Illinois
State Geological Survey

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

BULLETIN NO. 55

GEOLOGY AND MINERAL RESOURCES OF THE HERSCHER QUADRANGLE

BY

L. F. ATHY

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1928

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

JEFFERSONS PRINTING & STATIONERY CO.
SPRINGFIELD, ILLINOIS
1928

CONTENTS

ILLUSTRATIONS

TABLES

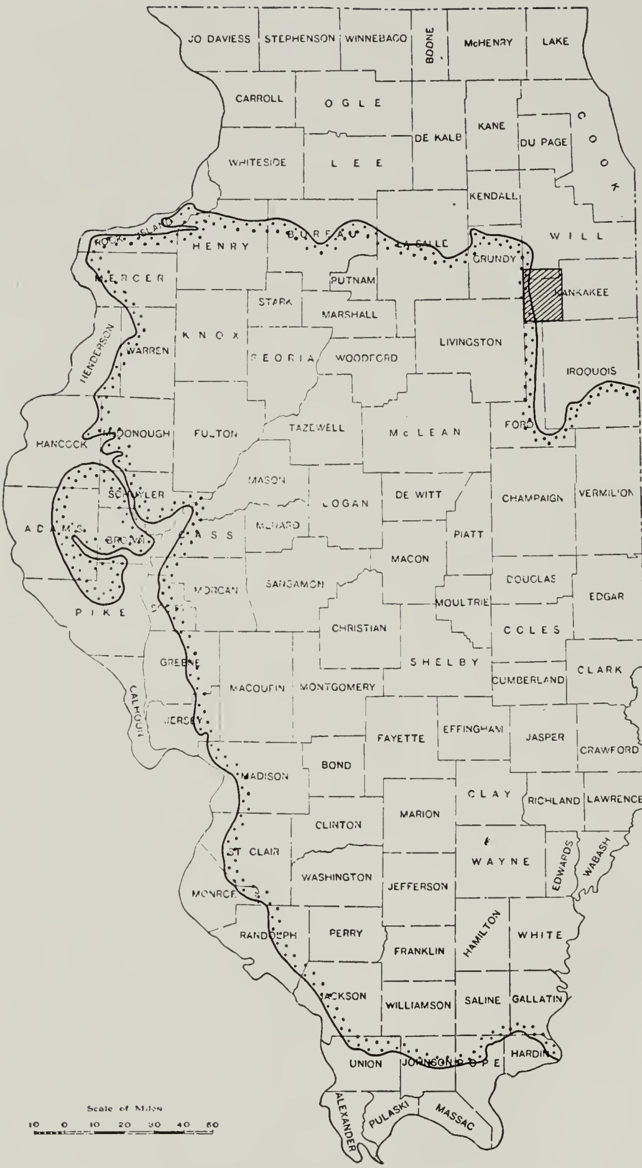


Fig. 1. Map of Illinois showing the location of the Herscher quadrangle. The stippled area marks the boundary of the Illinois coal field.

GEOLOGY AND MINERAL RESOURCES OF THE HERSCHER QUADRANGLE

By L. F. Athy

CHAPTER I—INTRODUCTION

Location of Area

The Herscher quadrangle lies about 40 miles southwest of Chicago, in western Kankakee and southern Will counties, and covers an area of about 221 square miles. Grundy and Livingston counties are on its western and Ford and Iroquois counties on its southern border. To the north of it is the Wilmington quadrangle and to the east is the Kankakee quadrangle. The area is situated between 88° and 88° 15′ west longitude and 41° and 41° 15′ north latitude. The quadrangle includes no large cities by means of which it may be conveniently located. Kankakee is about 7 miles east and Joliet 18 miles north of its boundaries. Kankakee River crosses the northeastern corner of the area. (See fig. 1.)

The east part of the quadrangle is underlain by Silurian formations, but the west part overlaps the northeastern edge of the Illinois coal measures. In addition to being glaciated it was crossed in the northern part by the Kankakee glacial torrent. The quadrangle is also so situated with respect to the Morris basin on the west and the Kankakee basin on the east that a study of it has contributed additional knowledge to regional history.

Acknowledgments

The writer is indebted to Mr. James R. Mitcham for assistance in the field work on which this report is based, done during the summer of 1924. During the investigations he was also greatly aided by the courteous cooperation of many people within the quadrangle and is indebted to the well drillers of the region, particularly to Mr. Charles Cummings of Gardner. Dr. M. M. Leighton, Chief of the State Geological Survey, and Professor T. E. Savage of the University of Illinois, offered valuable suggestions, criticisms, and information. The author is also obligated to several members of the faculty of the University of Chicago as well as to members of the State Geological Survey for helpful suggestions and criticisms in the preparation of the manuscript.

Topography

RELIEF

INTRODUCTION

The Herscher quadrangle lies in a region known physiographically as the Glaciated Plains, which is a portion of the Interior Lowlands. This

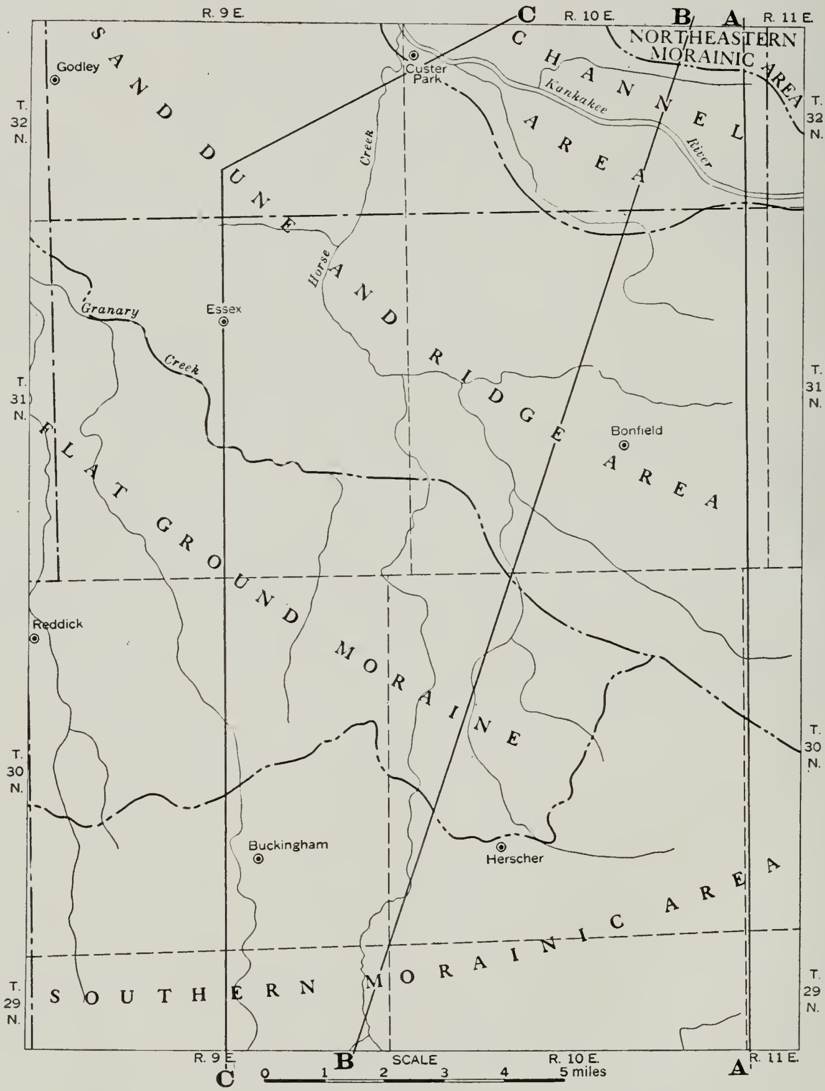


Fig. 2. Physiographic subdivisions of the Herscher quadrangle.

region has the rolling topography characteristic of most glacial drift, modified by the work of streams, lakes, and wind. The Herscher quadrangle in its southwestern portion is typical of the Glaciated Plains, but it is unique in its northeastern portion where it is crossed by the path of the Kankakee glacial torrent.

Very little of the topography, except the bluffs of Kankakee River, is determined by the bedrock of the area. Nearly all the relief features are constructional by glacial agencies, but in the path of the Kankakee glacial torrent they have been modified by running water and subsequently by wind.

The greater portion of the quadrangle is occupied by a shallow basin between two glacial moraines (broad ridges of glacial drift), one on the southern edge and one in the northeastern corner. Nowhere is the topography rough, and the total difference in altitude between the highest and lowest points in the quadrangle is only about 210 feet. Pilot Knob, in sec. 2, T. 29 N., R. 10 E., is the highest point and stands slightly more than 750 feet above sea level.

Physiographically the quadrangle may be divided into five distinct parts: (1) a northeastern morainic area, (2) an area of abandoned channels along Kankakee River, (3) an area of sand dunes and ridges, (4) an area of flat ground-moraine, and (5) a southern morainic area. Areas (1), (4), and (5) are glacial in origin, (3) is glacio-fluvial, modified by wind, and (2) is principally fluvial. (See figs. 2 and 3.)

NORTHEASTERN MORAINIC AREA

The northeastern morainic belt covers but a few square miles of the quadrangle. Its topography lacks the boldness and the knobs and kettles which are common to some moraines. Instead, it is a gently undulatory moraine. It is younger than the moraine which crosses the southern part of the quadrangle and may be a portion of the Rockdale moraine found farther north in the Wilmington and Joliet quadrangles,[1] or it may be a portion of the Minooka Ridge which, beginning at the head of Illinois River in the northeasten part of Grundy County,[2] extends northward along the eastern boundary of Kendall County into Kane County.

AREA OF ABANDONED CHANNELS ALONG KANKAKEE RIVER

The territory adjacent to Kankakee River is dissected by large channels that were cut by streams which marked the closing stages of the Kankakee glacial torrent (p. 66). A number of these channels are more than a quarter

---

[1] Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, pp. 71, 87-89, 1925. For the Wilmington quadrangle, personal communication with Dr Fisher.

[2] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. XXXVIII, pp. 319-321, 1899.

Culver, Harold E., Geology and mineral resources of the Morris quadrangle: Illinois State Geol. Survey Bull. 43, p. 153, 1923.

of a mile wide and 30 or 40 feet deep. Kankakee River throughout most of its course across the quadrangle has carved a narrow, steep-walled gorge in

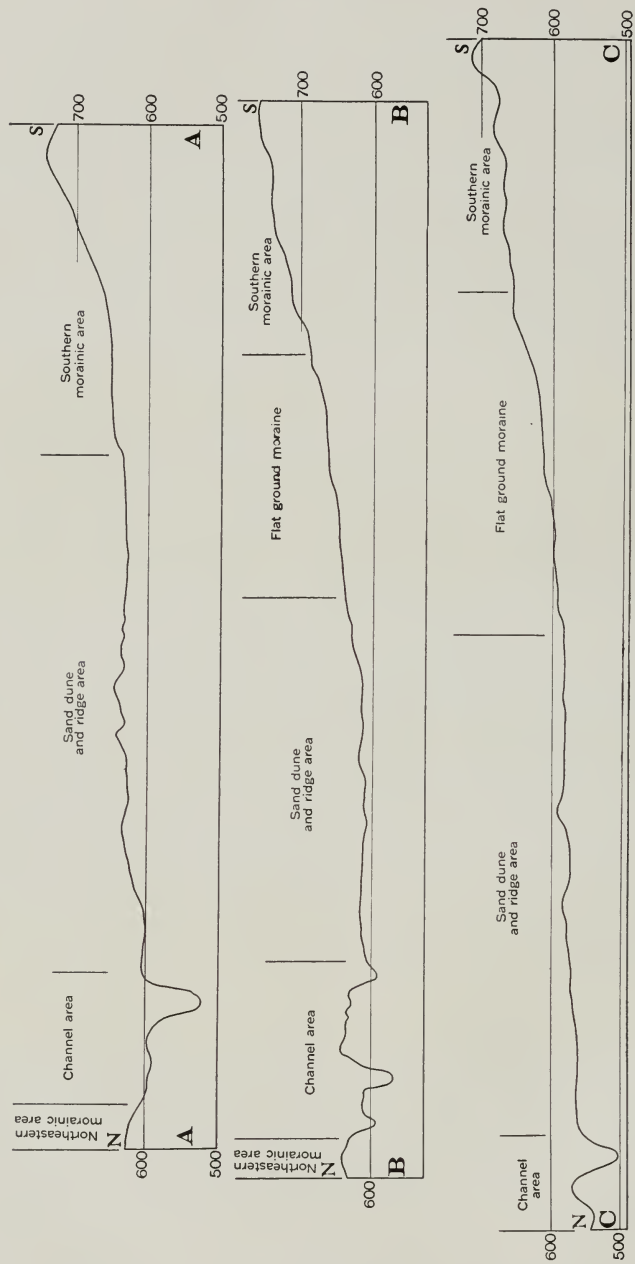


Fig. 3. Profiles of Herscher quadrangle along lines A-A, B-B, and C-C of fig. 2.

bedrock. For about three miles west of the Will-Kankakee county line, the bluffs of Kankakee River are 50 to 75 feet high, in few places more than

1500 feet apart, and are known as "The Palisades" (fig. 4). Small terraces and islands add to the scenic charm of the river.

AREA OF SAND DUNES AND RIDGES

Extending across the quadrangle in a northwest-southeast direction west and south of the channel area is an area 5 or 6 miles wide of sand dunes, sand

Fig. 4. Kankakee River from "The Palisades".

Fig. 5. A typical view in the sand dune area south of Kankakee River, in sec. 7, T. 31 N., R. 10 E.

ridges, rubble bars, and intervening swamps (see fig. 5). Many of the sand ridges in the area are 20 or 30 feet high, several miles long, and trend more or less parallel to the river. The irregular surface of this area is in striking contrast with that of the area to the south.

AREA OF FLAT GROUND-MORAINE

This area consists of the portion of the Marseilles ground-moraine that is covered by silt, sand, and fine gravel (Pl. I). It lies just north of the southern morainic area and is a part of the local "prairies". (See fig. 6.) In appearance the topography simulates the old lake flats which are so common in the states that border the Great Lakes. Rounded ridges of sand, few of which are more than 8 feet high, are scattered over the glacial drift and constitute the chief irregularities on the otherwise monotonous plain. The surface elevation increases from about 580 feet above sea level in the northwest portion to about 650 feet above sea level along the south border. The surface was modified by the Kankakee glacial torrent, to be described below.

Fig. 6. View on the Marseilles moraine southeast of Herscher.

SOUTHERN MORAINIC AREA

The portion of the quadrangle that is marked on Plate I as Marseilles terminal moraine constitutes what is herein called the southern morainic area. This area is characterized by broad, rounded knolls and wide shallow basins which are much more conspicuous in the terminal moraine than in the ground-moraine. Most of the basins, which were formerly enclosed, are now drained by streams and only the low ridges, which have been somewhat modified by erosion, remain as evidence of the original topographic expression of the glacial deposits. The north slope of the moraine averages about 20 feet per mile.

DRAINAGE

The two morainic ridges control the drainage and cause the streams from three-fourths of the quadrangle to flow into Kankakee River. The length of Kankakee River within the quadrangle is 8½ miles, and in this distance its fall is nearly 10 feet. It flows with a rather high velocity and is distinctly an eroding stream. It is cutting in bedrock, has a steep-walled channel, except near Custer Park, and with minor exceptions has no flood-plain.

The following data refer to Kankakee River at Custer Park:[3]

Drainage area of Kankakee River above Custer Park, 4,870 square miles.
Records from Nov. 6, 1914, to Sept. 30, 1918, made by a chain gauge, show:
  Maximum stage 13 feet, discharge 22,700 second-feet.
  Minimum stage 4.09 feet, discharge 250 second-feet (estimated).
  Mean discharge for year ending Sept. 30, 1918, 2,320 second-feet.

The main tributary of Kankakee River is Horse Creek, which heads in the morainic hills at the southern edge of the quadrangle and joins Kankakee River at Custer Park. Most of the remaining portion of the quadrangle is drained by Granary Creek, a branch of Mazon River.

Although still in a youthful stage of development, the drainage is fairly well established except in the swampy sand area south of Kankakee River. The swamps have been formed in geologically recent times as a result of the irregular drifting of sand across natural drainage lines.

Culture

The culture is decidedly rural. Herscher, the largest of nine villages within the quadrangle, has a population of only 460. Herscher, Buckingham, Reddick, Caberry, and Union Hill are the trade centers for a very rich agricultural region. Essex, Bonfield and Custer Park are trading towns in the sand belt. Godley is the one surviving coal-mining town, although coal has not been mined there for over a decade. Torino and Clarke City are the abandoned sites of once flourishing coal towns.

All of the quadrangle except the sand dune area is excellently adapted for agricultural purposes and is a part of the Illinois prairie land which is famous for its corn crops. Some good crops are raised in the drained lower portion of the sand dune area, especially north of Bonfield, but other parts of the sand dune area are not cultivated. A large portion of Reed township is so swampy that it can not be farmed.

Most of the wooded areas are on the sand hills and along Kankakee River and the lower portion of Horse Creek. The rich farming land bears very little timber.

A concrete road crosses the center of the quadrangle from east to west. The other roads, as a rule, are not improved. The ordinary dirt roads in the

---

[3] Grover, N. C., and Hoyt, W. A., Surface water supply of the United States, 1918; Part V, Hudson Bay and Upper Mississippi River basins: U. S. Geol. Survey Water-Supply Paper 475, pp. 126-127. 1921.

southern half of the quadrangle are usually in good condition, but the loose sand in the northern part makes traveling by automobile or with heavy loads extremely difficult. The Warner bridge on the Kankakee-Will county line is the only road-bridge over Kankakee River between Wilmington and Kankakee.

The region is well supplied with railroads. The main line of Wabash Railway from Chicago passes through Reddick, Essex, and Custer Park. A branch of Illinois Central Railroad passes through Herscher, Buckingham, and Caberry and swings north along the edge of the coal belt. A line of New York Central Railroad runs east and west through Reddick and Union Hill to Kankakee. Cleveland, Cincinnati, Chicago and St. Louis Railway passes through Essex and Bonfield, and Chicago and Alton Railroad crosses the northwest corner of the area.

CHAPTER II—DESCRIPTIVE GEOLOGY

Introductory Statement

By a study of the crustal formations of the earth, geologists have found that during the long history of the earth most areas have been submerged by ocean waters at various times and consequently have been areas of deposition, and at other times the same areas have been uplifted and subjected to erosion. These changes in the relations of land and sea, involving variations in the configuration of shore lines and in the sizes of continents and continental shelves, were caused by warping movements of the crustal portions of the earth. These changes in turn had pronounced effect upon climatic conditions and the evolution of various forms of animal and plant life. By studying the fossil forms, the character, extent, thickness, structure, and location of rock strata, and the occurrence of unconformities which mark interruptions in deposition, geologists have worked out a considerable part of the history of the earth and have differentiated the following eras and periods:

Table 1.—*Geologic Chronology*

Eras		Periods	Dominant Life (After Schuchert)
Cenozoic	Quaternary	Recent	Age of Man
		Pleistocene	
	Tertiary	Pliocene Miocene Oligocene Eocene	Age of mammals and flowering plants
Mesozoic		Cretaceous Comanchean	Age of reptiles
		Jurassic Triassic	Age of reptiles and medieval floras
Paleozoic		Permian Pennsylvanian	Age of amphibians and ancient floras
		Mississippian Devonian	Age of fishes
		Silurian Ordovician Cambrian	Age of invertebrates
Proterozoic			Age of primitive invertebrates
Archeozoic			Age of larval life
Formative eras of Earth History			Probably dawn of unicellular life

In the Herscher quadrangle the consolidated rock formations which immediately underlie the mantle-rock consist of limestone, shale, and sandstone. Limestone underlies approximately three-fourths of the quandrangle. With the exception of a few scattered ledges the rock is concealed by a mantle of loose, surficial material whose thickness varies from a few inches to nearly 200 feet. Because of this covering, the geologic column (fig. 7) and the areal map (Pl. I) have been based largely on the records of borings into the solid rock for water, oil, gas, or coal. As no borings penetrate the solid rock in the northwestern part of the area east of the coal basin, and as no outcrops occur there, nothing very definite is known concerning the character and the areal distribution of the bedrock in that vicinity.

The outcropping rocks represent three of the seven Paleozoic systems—the Ordovician, Silurian, and Pennsylvanian. None of the borings is known to have penetrated rocks older than early Ordovician.

Not all the strata represented in the columnar section (fig. 7) are encountered in any one well, but the section is compiled from all available well records and rock outcrops in the quadrangle. The Pennsylvanian, for instance, generally rests not on Niagaran strata but on Alexandrian or Richmond. In the columnar section the strata are arranged according to age, and the indicated thickness is the average for the area.

The following are logs of the deeper wells of the quadrangle. The more detailed records are from the files of the State Geological Survey:

Oil Test near Herscher, NE. ¼ NW. ¼ sec. 32, T. 30 N., R. 10 E., Kankakee County

	Thickness	Depth
Pleistocene and Recent systems	*Feet*	*Feet*
Soil and till	41	41
Silurian system		
Alexandrian series		
Limestone	14	55
Ordovician system		
Richmond formation		
Shale, blue	84	139
Galena-Platteville formations		
Limestone, gray	461	600
St. Peter formation		
Sandstone	...	...

Lee Wadleigh well, sec. 17, T. 29 N., R. 10 E., Iroquois County, about half a mile south of the Herscher quadrangle

	Thickness	Depth
Pleistocene and Recent systems	*Feet*	*Feet*
Soil	4	4
Clay till	116	120
Gravel	4	124

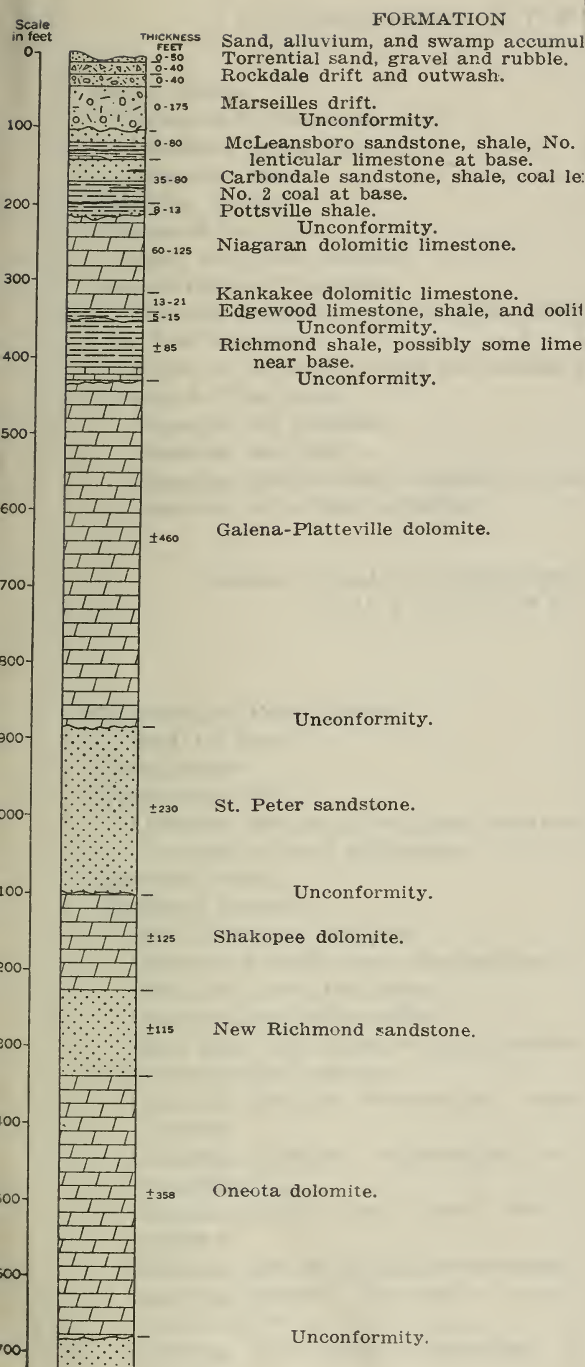


Fig. 7. Columnar sectio

im
sto
W
of
20
ar
th
ro
ou
an

the
to

co
rec
sta
mo
the

de

Ple

Sil
A

Or
F

C

S

1

Ple

Lee Wadleigh well, sec. 17, *T.* 29 *N., R.* 10 *E.*—Concluded

	Thickness *Feet*	Depth *Feet*
Silurian system		
Niagaran and Alexandrian series		
Limestone, brown, hard	10	134
Limestone, gray	25	159
Ordovician system		
Richmond formation		
Shale, blue, some limestone	131	290
Galena-Platteville formations		
Dolomite, crystalline to subcrystalline, pyritiferous	460	750
St. Peter formation		
Sandstone, gray-white; grains well rounded, moderately fine	225	975
Prairie du Chien series		
Limestone and sandstone	6	981
Limestone and shale	70	1051
Limestone, grayish-white, crystalline to subcrystalline	70	1121
Limestone, tan to gray, crystalline	180	1301

Kankakee Oil and Gas Company well near Essex, SW. ¼ *SW.* ¼ *sec.* 11, *T.* 31 *N., R.* 9 *E., Kankakee County*

	Thickness *Feet*	Depth *Feet*
Pleistocene and Recent systems		
Sand, till, gravel	65	65
Silurian system		
Alexandrian series		
Limestone, dark gray to tan, shaly, subcrystalline to crystalline; considerable pyrite and limonite	31	96
Ordovician system		
Richmond formation		
Shale, calcareous, dark gray	7	103
Limestone, brownish-gray, subcrystalline, some chert	12	115
Shale, gray; some lime layers	7	122
Limestone, gray, subcrystalline	13	135
Shale, gray, with limestone layers, pyritiferous	45	180
Galena-Platteville formations		
Limestone, dolomitic, brownish-gray, containing pyrite and limonite	56	236
Limestone, dolomitic, yellowish-gray to pinkish-gray, subcrystalline	44	280
Limestone, dolomitic, gray to nearly white, subcrystalline, some bitumen	20	300
Limestone, light tan to gray, subcrystalline	10	310
Limestone, dolomitic, light gray to tan or buff, some carbonaceous matter	20	330
Limestone, light gray, subcrystalline, some carbonaceous material	10	340

Custer Park well, on the section line between secs. 24 and 25, T. 32 N., R. 9 E., Will County

	Thickness Feet	Depth Feet
Pleistocene and Recent systems		
Soil and gravel	5	5
Ordovician system		
Richmond formation		
Shale	25	30
Galena-Platteville formations		
Limestone	80	110
Shale (possibly Decorah)	60	170
Limestone	330	500
St. Peter formation		
Sandstone	235	735
Prairie du Chien series		
Limestone (Shakopee)	120	855
Sandstone (New Richmond)	100	955
Limestone (Oneota)	125	1080

Cambrian System

Rocks of the Cambrian system have not been penetrated by any wells in the quadrangle, but they are undoubtedly present under the area. Cambrian strata were entered by a drilling in the NW. ¼ sec. 25, T. 34 N., R. 6 E., in the Morris quadrangle at a depth of 1202 feet.[1] A well at Minooka, drilled in 1886, is reported to have penetrated the Cambrian rocks, but no record is available. In 13 wells at Joliet the Cambrian strata were struck at depths varying from 1225 to 1405 feet, and at Streator at 1103 feet. At Custer Park the Cambrian would probably be encountered at a depth of from 1100 to 1150 feet, and at Herscher it would probably be encountered about 100 feet deeper.

The Cambrian system contains sandstone, some limestone, and considerable shale. Some of the Cambrian sandstones which have been penetrated by wells in northern Illinois are highly porous, white or gray to reddish in color, and are composed of well-rounded grains. These strata are economically important as water horizons; the flow from wells in them is usually large.

Ordovician System

The oldest rocks that have been penetrated in the wells of the Herscher quadrangle are early Ordovician in age; the oldest formation outcropping at the surface is late Ordovician. At Coal City the thickness of Ordovician strata is 1203 feet, and at Custer Park it is 1040 feet.

The Ordovician rocks are divided into three series which may be readily recognized. These are the Lower Ordovician or Prairie du Chien series,

[1] Culver, Harold E., Geology and mineral resources of the Morris quadrangle: Illinois State Geol. Survey Bull. 43, p. 105, 1923.

the Middle Ordovician or Mohawkian series, and the Upper Ordovician or Cincinnatian series.

LOWER ORDOVICIAN OR PRAIRIE DU CHIEN SERIES

The Lower Ordovician or Prairie du Chien series, formerly known as the "Lower Magnesian" limestone, is typically made up of three members, the Oneota dolomite at the bottom, the New Richmond sandstone in the middle, and the Shakopee dolomite at the top.

The exact thickness of the Prairie du Chien series in the Herscher quadrangle is not known, but it is probably between 350 and 400 feet. It varies from 150 to 600 feet in Illinois Valley, as determined from well records.

In the Custer Park well the series consists of the following:

	Thickness *Feet*	Depth of bottom *Feet*
Limestone (Shakopee)	120	855
Sandstone (New Richmond)	100	955
Limestone (Oneota not completely penetrated)	125	1080

This alteration of limestone and sandstone formations is typical of the Prairie du Chien series in Illinois Valley.

In a well at Coal City, north of the quadrangle, these three formations are represented, in descending order, by 125 feet of Shakopee sandy limestone, 113 feet of New Richmond sandstone, and 134 feet of Oneota limestone. Analogous situations are found in the Hoge well in the western part of the Morris quadrangle[2] and in wells in LaSalle County.[3]

The New Richmond formation is not always a sandstone and may be a sandy limestone, as for instance in the Wadleigh well:

	Thickness *Feet*	Depth of bottom *Feet*
Shakopee formation		
Limestone and sandstone, containing pyrite, iron oxide, and magnetite	6	981
Limestone, fine-grained, containing some pyrite, iron oxide, and chert	70	1051
New Richmond formation		
Limestone, grayish-white, crystalline to sub-crystalline, containing iron oxide and quartz grains resembling silicified oolite	70	1121
Oneota formation		
Limestone, tan to gray, crystalline, with some iron, pyrite, chalcedonized quartz, and quartz resembling silicified oolite	180	1301

2 Culver, Harold E., op. cit. pp. 105-107.

3 Anderson, C. B., The artesian waters of northeastern Illinois: Illinois State Geol. Survey Bull. 34, pp. 199, 202, 1919.

Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois State Geol. Survey Bull. 37, p. 32, 1919.

The correlations of strata in these references is subject to revision, according to Thwaites, F. T., Stratigraphy and geologic structure of northern Illinois: Illinois State Geol. Survey, Report of Investigations 13, 1927.

The upper 76 feet of limy sediments in this record probably represents only the lower part of the Shakopee formation, the upper part having been eroded before the overlying sediments were deposited. Similar variations in the character of the New Richmond formation are shown in the records of the Peddicord well near Marseilles[4] and of the Joliet wells.[5]

MIDDLE ORDOVICIAN OR MOHAWKIAN SERIES

This series also consists of three formations in the Herscher quadrangle. The lowest one is the St. Peter sandstone, the middle one the Platteville limestone, and the upper one the Galena dolomite. The St. Peter sandstone is readily identifiable in well logs, but the last two are not always. They are therefore referred to in this report as the Platteville-Galena formations.

It is impossible to establish the true character of the contact between the middle and lower series of the Ordovician or between the St Peter and the Platteville-Galena formations as in or near the quadrangle there are only two wells which penetrate these formations, but where the two contacts have been studied in northern Illinois they represent erosional unconformities.

The thickness of the Middle Ordovician series is 705 feet at Custer Park, 685 feet in the Wadleigh well, and 620 feet in the Gardner city well.

ST. PETER SANDSTONE[6]

The St. Peter formation has been found from 500 to 750 feet below the surface in the Herscher quadrangle. The differences in depth are due to one or more variables, such as differences in the surface elevations, irregularities in the top and bottom surfaces of the formation, and changes in the structure.

A study of the only drill core taken from the St. Peter in this area shows the formation to consist of a gray-white sandstone made up of moderately fine, well-rounded grains. Its thickness is 225 feet in the Wadleigh well, 235 feet in the Custer Park well, and 100 feet in the Gardner city well.

The nearest outcrops are in LaSalle County, and published descriptions are available.[7]

---

4 Anderson. C. B., op. cit. p. 197.

5 Fisher, D. J., The geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, pp. 141-152, 1925.

6 For a discussion of the problems of this formation see: Dake, C. L., The Problem of the St. Peter sandstone: University of Missouri School Mines and Metall., tech. ser., vol. 6, No. 1, 1921.

7 Sauer, Carl O., Cady, Gilbert H., and Cowles, Henry C., Starved Rock State Park and its environs: The Geographic Society of Chicago, Bull. 6, pp. 20-25, 1918 (published by the University of Chicago Press).

Cady, Gilbert H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois State Geol. Survey, Bull. 37, pp. 37-40, 1919.

PLATTEVILLE-GALENA FORMATIONS

The Platteville-Galena formations are found in the Herscher quadrangle at depths ranging from 30 to 290 feet; the wide variation is due to surface irregularities, local structure, and unevenness of the upper surface of the Galena limestone. Possibly in some borings the lower part of the overlying Richmond formation, which is locally limestone, has been confused with the Galena formation.

The Platteville-Galena formations consist mainly of limestone and dolomite which have a crystalline to subcrystalline texture and usually a light or brownish gray color. In the Wadleigh well the entire thickness of 460 feet of Platteville-Galena strata is pyritiferous dolomite. In the Essex well there are 160 feet of interstratified limestone and dolomite containing some carbonaceous material.

Two other members or formations are recognized in some places, the Glenwood member in the basal part of the Platteville formation, and the Decorah formation which occurs between the Platteville and Galena formations. The Glenwood member is represented by 15 feet of "transition beds" of dolomitic sandstone and shale in the well at the Kankakee Insane Asylum[8] and by 100 feet of dolomitic sandstone in a well at Gardner, about 3 miles west of the Herscher quadrangle. It would seem therefore that the member is present within the quadrangle. The member has been reported for many localities in northern Illinois.[9] In some places it is a greenish shale.

The Decorah formation is best developed in northwestern Illinois and adjacent states. In the Herscher quadrangle it may be represented by the 60 feet of shale between limestone strata in the Custer Park well. In the Coal City well there is 30 feet of sandstone and in the Gardner well there is 35 feet of shaly limestone that are assigned to the Decorah formation.

UPPER ORDOVICIAN OR CINCINNATIAN SERIES

RICHMOND (MAQUOKETA) FORMATION

The Richmond formation, commonly called the Maquoketa formation, especially in northwestern Illinois and northeastern Iowa, is the only formation of Upper Ordovician age that is known in Illinois. It is the oldest formation that crops out in the Herscher quadrangle and may be seen at many points along Kankakee River and at a few places along Horse Creek. The

8 Udden, J. A., Some deep borings in Illinois: Illinois State Geol. Survey Bull. 24, pp. 52-53, 1914.

9 Bevan, Arthur, The Glenwood beds as a horizon marker at the base of the Platteville formation: Illinois State Geol. Survey Report of Investigations No. 9, 1926.
Culver, H. E., op. cit., pp. 108-113.
Fisher, F. J., op. cit., pp. 151-152.
Cady, G. H., op. cit., pp. 39-40.

Richmond formation in northeastern Illinois has been correlated with the Waynesville formation of Indiana.[10]

A study of well logs and outcrops determines that the composition of the formation varies greatly. In the Essex well the Richmond formation consists of 7 feet of dark gray, calcareous shale; 12½ feet of brownish-gray subcrystalline limestone; 7 feet of gray shale; 13 feet of gray, subcrystalline limestone; and 45 feet of gray, pyritiferous shale containing limestone layers. At Custer Park 25 feet of shale was recorded; the upper part of the forma-

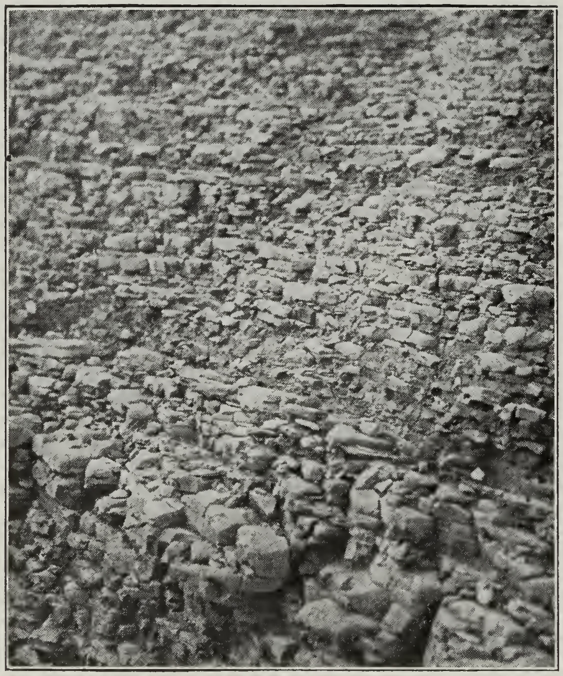


Fig. 8. Outcrop of Richmond shale containing thin beds of limestone, along Horse Creek just south of Custer Park, in sec. 24, T. 32 N., R. 9 E.

tion had been eroded. The Wadleigh well penetrated 131 feet of blue shale containing some limestone beds.

A few inches to 8 feet of olive-green to drab, locally calcareous Richmond shale outcrops in the south bank of Kankakee River half a mile west of the Warner bridge, in sec. 36, T. 32 N., R. 10 E.; in the north bank of the river in the east part of sec. 35 and at several places in the east part of

10 Savage, T. E., Richmond rocks of Iowa and Illinois: Am. Jour. Sci., 5th ser., vol. 8, pp. 411-427, 1924.

sec. 27, same township; in a tile-ditch west of Custer Park; and along Horse Creek 2 miles east of Essex. The shale in these outcrops is decidedly plastic when wet, but when dry it is brittle and breaks with a conchoidal fracture. It has poor cleavage, although it occurs in even, continuous beds, most of which are one-fourth to half an inch thick and few are more than 1½ inches thick.

On the east bluff of Horse Creek, just south of Custer Park, there is exposed 8 feet of olive-green, plastic Richmond shale in which there are thin beds of nonfossiliferous, subcrystalline, gray limestone. (See fig. 8.) The beds of limestone are each less than one inch thick and occur at intervals of 8 inches to 1½ feet throughout the section. These strata represent only part of the upper Richmond formation, as the higher part of the formation, as well as overlying strata, has been eroded.

Cores of holes drilled in the bottom of Kankakee River show a crystalline, highly fossiliferous limestone below typical green Richmond shale.

Table 2—*Mechanical analyses of Richmond shale (in per cent of the total sample by weight)*

Sample No.	Soluble Material	Residue					
		Total	Coarse Sand 1-.5 mm.	Medium Sand .5-.25 mm.	Fine Sand .25-.1 mm.	Silt .1-.01 mm.	Mud .01 mm.
50	21.8	78.2		.3	6.9	36.8	34.2
51	10.8	89.2		.2	4.7	34.5	49.8
		Average		.25	5.8	35.65	42.0

The fossils in the limestone suggest that the rock represents the same limestone phase of the Richmond formation that outcrops in the banks of the river at Wilmington.[11]

Mechanical analyses[12] of two samples of Richmond shale provided the results shown in Table 2.

11 Savage, T. E., op. cit.

12 The mechanical analyses which are included in this report were made by weighing a dried sample, treating it with dilute hydrochloric acid, drying and reweighing the residue to determine the soluble material, and then determining the grain size of the residue by the rate of fall of the material in water, the ratio between size of grain and rate of fall having been determined by previous workers. The usual procedure in making mechanical analyses of rocks is discussed in the following references:

Milner, Henry B., Sedimentary petrography, London, 1922.

Crook, Thomas, Economic mineralogy, pp. 89-112, 1921.

Hatch, F. H., and Rastall, R. H., Appendix to the petrology of sedimentary rocks, 1913.

Boswell, P. G. H., The application of petrology and quantitative methods of stratigraphy: Geol. Mag., ser. 6, vol. 3, pp. 105 and 163, 1916.

Littlefield, M. S., Molding sands of Illinois: Illinois State Geol. Survey Bull. 50, 1925.

McCaughey, W. J., and Fry, W. H., The microscopic determination of soil-forming minerals: U. S. Dept. of Agriculture Bull. 91, 1913.

Sample No. 50 was taken along Horse Creek just south of Custer Park, and sample No. 51 is from "The Palisades" in sec. 35, T. 32 N., R. 10 E. Tests with bromoform showed that no heavy minerals were present. The residual grains coarser than 0.01 millimeter in size consist entirely of quartz and are angular to rounded in shape.

Although their relations in the Herscher quadrangle are not definitely known, the Richmond formation and the underlying Galena limestone are usually considered to be separated by an erosional unconformity.

In the east part of the quadrangle the Richmond formation underlies Alexandrian strata of the Silurian system, from which it is also separated by an erosional unconformity. The undulations of the old erosional surface on the Richmond formation can be traced at almost any outcrop at which the contact is exposed, and in secs. 26 and 27, T. 32 N., R. 10 E., the surface has a relief of more than 25 feet. The contact between green Richmond

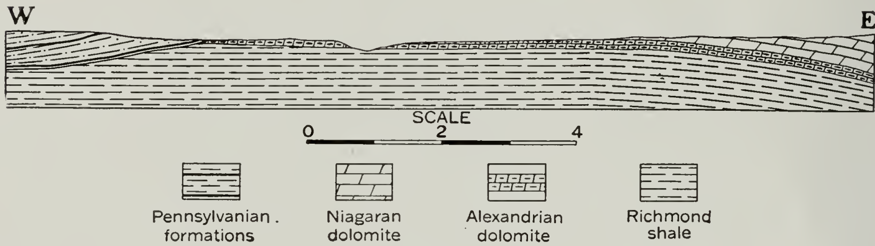


Fig. 9. Cross-section of the Herscher quadrangle along an east-west line one mile south of the Kankakee-Will county line.

shale and yellowish Alexandrian dolomite is sharp and is exposed in nearly all of the outcrops of Richmond shale along Kankakee River.

In the west part of the quadrangle the Richmond formation locally underlies strata of Pennsylvanian age. In the vicinity of Reddick and Buckingham, in the southwest part of the quadrangle, a limestone, presumably of Silurian age, underlies the coal-bearing formations and probably overlies the Richmond formation. North of Essex few wells reach bedrock, so that it is impossible to determine whether or not a belt of Richmond formation should be shown between the areas of Pennsylvanian and Silurian strata on the areal map (Pl. II). The general relations of the Richmond, Silurian, and Pennsylvanian formations in the area are shown in figure 9.

Silurian System

Silurian strata have a greater areal distribution in the quadrangle than those of any other Paleozoic system. In nearly all of the area east of the Coal

Basin, or in approximately three-fourths of the quadrangle, the unconsolidated surface materials are underlain by rock of Silurian age.

The eastern edge of the Coal Basin marks the approximate western extent of the Silurian rocks in the quadrangle, but at one time they probably covered the whole interior of Illinois. Pre-Pennsylvanian erosion separated the Silurian rocks of northeastern Illinois from those of northwestern Illinois and left the western margin of the northeastern portion, in the Herscher quadangle, about where it is today (Pl. II). Erosion subsequent to the deposition of the Pennsylvanian formations exposed the underlying Richmond shale in places.

The total thickness of Silurian strata increases eastward to more than 100 feet in places along the eastern edge of the quadrangle; the increase in thickness is due to the fact that the beds dip eastward and also that the surface of the bedrock rises toward the east (fig. 9).

In spite of the wide distribution of these strata in the quadrangle, outcrops of them are rather limited in number and extent because they are thickly covered by Pleistocene deposits. Most of the outcrops are along Kankakee River or in its vicinity, with the exception of outcrops at Bonfield, Lehigh, and near Essex, and consequently the study of Silurian strata is confined to the northeastern part of the quadrangle.

In Kankakee Valley the Silurian system consists of the Alexandrian and the Niagaran series, which are almost exclusively dolomitic limestones of varying composition. Because the lithology of the Niagaran and Alexandrian series is similar, it is difficult to distinguish one from the other in well records and consequently the mapping of the boundary between these two series is only approximate over the southern half of the area.

ALEXANDRIAN SERIES

The name Alexandrian as first proposed[13] included all Silurian strata between the Maquoketa formation and Brassfield (Ohio Clinton) limestone in Illinois and eastern Missouri but was later extended to include the Brassfield limestone.[14] Strata included in the Alexandrian have been referred to under various names, such as Girardeau, Bowling Green, Edgewood, Sexton Creek, Channahon, Kankakee, and Essex limestones, Noix oolite, and Orchard Creek shale (see Table 3).

Alexandrian rocks are known to outcrop in two areas in Illinois. One area is a discontinuous belt along Mississippi River from southern Illinois north to

13 Savage, T. E., On the Lower Paleozoic stratigraphy of southwestern Illinois: Am. Jour. Sci., 4th ser., vol. 25, pp. 433-434, 1908.

14 Savage, T. E., Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, p. 352, 1913.

TABLE 3—*Provisional correlation of Silurian strata in Illinois and neighboring areas*

System	Series		Illinois		Iowa	Missouri	Wisconsin	Michigan	Temisca-ming	Hudson Bay	Indiana	Western New York
		Southwestern	Northeastern	Northwestern								
Silurian	Niagaran	Lockport		Port Byron	Port Byron	Gower (in part)	Bainbridge			Guelph		Huntington	Guelph
			Racine	Racine			Racine (including Guelph)	Racine	Lockport	Attawapiscat	Louisville	Lockport
		Joliet	Waukesha Joliet	Waukesha Joliet	Hopkinton		Waukesha	Manistique		Ekwan	Waldron	
	Clinton											Upper Clinton Lower Clinton
	Alexandrian	Sexton Creek (Brassfield)	Kankakee (Brassfield)	Kankakee (Brassfield) ("Waucoma")	Waucoma	Brassfield	Byron	Burnt Bluff	Wabi	Severn	Brassfield	Cataract
		Edgewood Bowling Green Cyrene Noix oolite	Edgewood Bowling Green Essex; Channahon Noix	Edgewood ("Winston")	Edgewood	Edgewood	Mayville	Mayville		Port Nelson		
		Girardeau Orchard Creek										

Copied from Savage, T. E., Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 513-534, 1926, with further subdivisions for various parts of Illinois according to the same reference.

Pike County; the other is in the northeastern part of the State and includes part of the Herscher quadrangle.

In the Herscher quadrangle the Alexandrian series includes two formations, the Edgewood limestone below and the Kankakee (Sexton Creek) limestone above. Within the quadrangle the series rests unconformably upon the Richmond shale and varies in thickness from 20 to more than 30 feet.

Generalized section of the Alexandrian series in the Herscher quadrangle

	Thickness *Feet*
Unconformity (?)	
Kankakee formation	13-21
Dolomite, gray to yellowish or reddish-brown; fairly thick-bedded; *Stricklandinia pyriformis, Clathopora frondosa, Rhinopora* near *verrucosa,* and *Zaphrentis sp.* in zone near the top; *Pentamerus oblongus* about 3 inches lower; *Platymerella manniensis* near the base.	
Edgewood formation	13-29
Essex member	8-21
Limestone, magnesian, thin-bedded, yellow or blue, containing few fossils	5-11
Limestone, soft, gray or brown, and limy shale; species of *Atrypa, Camarotoechia, Rhynchotreta, Schuchertella, Homoeospira,* and other genera	2-7
Limestone, shaly, blue or gray, soft; containing few or no fossils	1-3
Noix oolite member	5-8
Shale, calcareous or dolomitic, ferruginous, oolitic, green, yellow or brown; no fossils.	

EDGEWOOD FORMATION

GENERAL DESCRIPTION

Edgewood strata crop out along the north bank of Kankakee River in secs. 26 and 27 and along the south bank in secs. 35 and 36, T. 32 N., R. 10 E., in the bluffs of Horse Creek west of Custer Park, and along Horse Creek two miles east of Essex (Pl. I). The portion of these outcrops designated as Edgewood in this paper includes all Alexandrian strata between the top of the Richmond shale and a fossiliferous horizon containing *Platymerella manniensis.*

The Edgewood formation can not be accurately differentiated from the Kankakee formation in many of the well logs of the quadrangle, and so its exact extent in the southern portion could not be determined.

The thickness of the formation is not very great in this area, probably not exceeding 25 feet. Exposed thicknesses range from 5 to 16 feet. The following thicknesses of Edgwood were measured at different places within the quadrangle. Where the exact figures are not given, the total thickness was not exposed.

	Thickness	
	Feet	*Inches*
Eastern part of sec. 27, north bluff of Kankakee River	8	2
Western part of sec. 27, north bluff of Kankakee River	8	9
Central part of sec. 36, north bluff of Kankakee River............(approx.)	8	..
Western part of sec. 36, south bluff of Kankakee River	5	3
Eastern part of sec. 35, ravine south side of Kankakee River	6	5
Horse Creek, a quarter of a mile west of Custer Park	15	7
Horse Creek, two miles east of Essex	9	2
	(to 11 ft.)	

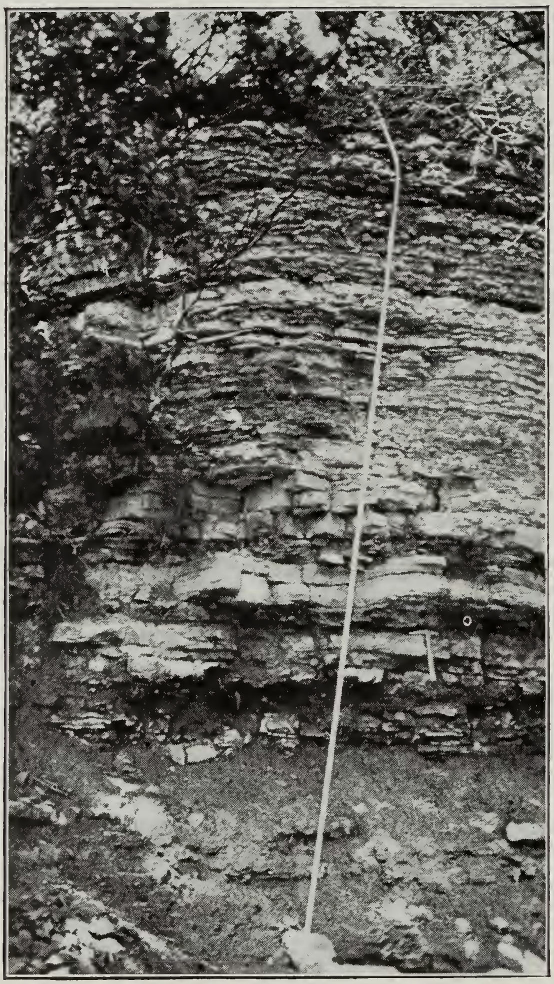


Fig. 10. Outcrop of Kankakee and Edgewood formations along the north bluff of Kankakee River, sec. 27, T. 32 N., R. 10 E. The head of the hammer marks the contact of the two formations. A spring which issues at the contact of the Richmond and Edgewood formations is marked by the lower end of the iron pipe.

The Edgewood strata are variable in character. They include shaly, ferruginous, oolitic dolomite; calcareous, ferruginous, oolitic shale; calcareous shale; yellowish-brown dolomitic limestone; blue limestone; and shaly dolomite. Very few outcrops show strata having the same characters. In the Herscher quadrangle the Edgewood formation consists of two members—a lower oolitic member, called the Noix oolite, and an upper limestone member, called the Essex limestone.

NOIX OOLITE MEMBER

The oolite member of the Edgewood formation in the Herscher quadrangle, herein referred to the Noix oolite, is exposed at several places along Kankakee River in secs. 26, 27, and 35, T. 32 N., R. 10 E., where it is made up entirely of an oolitic, calcareous ferruginous shale. An outcrop (fig. 10) in the east part of sec. 27, T. 32 N., R. 10 E., in the north bluff of Kankakee River, exposes the following typical section:

	Thickness	
	Feet	*Inches*
Niagaran dolomite	1	..
Kankakee dolomite, *Platymerella manniensis* in the bottom bed	17	10
Edgewood formation		
Noix oolite member (total thickness 8 feet 2 inches)		
11. Dolomite, oolitic, ferruginous; weathered to earthy limonite on the surface	..	4
10. Dolomite, oolitic, shaly; reddish-brown, hard, ferruginous; in 4-inch beds	1	..
9. Shale, oolitic, calcareous, brown; crumbles between the fingers like dry loam	..	8
8. Shale, oolitic, calcareous, reddish-brown, irregularly bedded; much weathered, too hard to break with fingers; secondary "iron" bands; spherulites green	1	..
7. Shale, calcareous, clayey, yellowish-green, few spherulites	..	3
6. Shale, mottled purple and yellowish-green; crumbles like loam soil; few spherulites	..	5
5. Shale, dolomitic, very oolitic, purplish; spherulites same color as rock; rock in thin beds, contains some greenish-yellow clay, crumbles like rotten wood	..	6
4. Oolitic beds, calcareous, olive-green, weathered brown on exterior, hard; spherulites, calcareous, white to yellow	..	4½
3. Shale, oolitic, calcareous, green; contains very soft and shaly nodules of iron	..	1
2. Shale, oolitic, calcareous, green; weathers dark reddish-brown; rather hard; cleaves along bedding	..	6½
1. Shale, oolitic, calcareous, reddish-brown, ferruginous; cleaves along bedding; uneven fracture; can be crushed with the fingers; spherulites, coffee-brown	3	..
Richmond shale, olive-green and plastic		

The strata in the above section contain much calcite which fills the joints and occurs along the bedding planes on the face of the outcrop. The calcite is formed as a result of the evaporation of ground-water which becomes charged with calcium carbonate as it passes through the overlying Niagaran and Kankakee limestones. The downward movement of these waters is blocked by the impervious Richmond shale so that the rocks above the shale become saturated, a lateral circulation is developed, and springs and seeps occur at the Richmond-Edgewood contact. The rock near these seeps in many places is coated with calcite which was deposited as the water evaporated.

The following section of oolite is exposed in the east part of sec. 35, T. 32 N., R. 10 E., in a ravine that enters Kankakee River from the south:

	Thickness Feet	Inches
Edgewood formation		
Noix oolite member		
Shale, yellowish, limy, thin-bedded, soft, contains a few spherulites; weathers in places to clay	1	3
Limestone, oolitic, ferruginous; weathers light or dark brown; in massive beds up to 1 foot thick	5	2

Less than half a mile east of this outcrop, in sec. 36, where the whole thickness of the Edgewood formation in this locality is exposed, there is no trace of the oolite member. The abrupt change illustrates the horizontal variation that may occur in the Edgewood strata.

Neither the well cuttings from the area south of Kankakee River nor the outcrops which occur there show any oolite. It is quite probable that this member is confined to the northern part of the quadrangle and is a very local, shallow-water phase of the Edgewood formation.

Fossils were not found in the oolite at any of its outcrops within the area.

A phase of the oolite member slightly different from that just described is exposed in a ravine north of Kankakee River, in sec. 26, T. 32 N., R. 10 E. The section is as follows:

	Thickness Feet	Inches
Kankakee formation		
Dolomite, brown, hard, containing *Platymerella manniensis* at the base	6	..
Edgewood formation		
Noix oolite member		
Limestone, shaly, pistachio green; weathers yellowish-brown; quite hard	..	2
Shale, limy, buff-colored, soft; weathers to an olive-drab, earthy material; contains small iron concretions and a few oolite grains, (lower portion concealed)	2	3

The Edgewood strata represent the upper shaly phase of the oolite as it occurs in some places along Kankakee River.

Mechanical analysis of the Noix oolite. The following analyses were made of samples from the Noix oolite as described in the geologic section on page 33. The numbers of the beds correspond to those on that page.

TABLE 4—*Mechanical analyses of the Noix oolite (in per cent of the total sample by weight)*

Bed	Soluble material	Residue					
		Total	Coarse sand 1-.5 mm.	Medium sand .5-.25 mm.	Fine sand .25-.1 mm.	Silt .1-.01 mm.	Mud .01 mm.
No. 11	60.70	39.30		.30	6.90	25.45	6.65
No. 7	26.80	73.20	.10	.15	12.10	42.50	18.35
No. 6	22.45	77.55	.15	.25	10.75	36.55	30.05
No. 5	43.90	56.10	7.40	4.70	6.75	28.85	8.40
No. 4	27.75	72.25		5.90	34.55	21.35	10.45
No. 3	29.70	70.30		3.15	18.10	20.20	28.85
No. 2	37.15	62.85		.65	37.95	14.25	10.05
No. 1	46.90	53.10	5.15	1.40	15.10	19.00	12.45
Average	36.92	63.08	1.60	2.06	17.77	26.02	15.68

In bed No. 11 the oolite grains are calcareous and dissolve in acid; for that reason the percentage of soluble material is large. In No. 5 most of the oolite grains are siliceous, and only a small proportion of them are soluble in acid. The siliceous oolite grains represent the 7.4 per cent and the 5.15 per cent of coarse sand recorded in the table.

The analyses show that the rock is really an oolitic, calcareous shale. A thin section of a sample from No. 2 bed corroborates this for it shows quartz grains in juxtaposition and the interstices filled with calcite or dolomite and a little silica.

The grains larger than .5 millimeter in diameter are all iron-stained siliceous spherulites. Approximately 95 per cent of those between .5 and .25 millimeter and the remaining 5 per cent are angular to slightly rounded quartz grains. Not all of the samples contain spherulites between .25 and .1 millimeter, although fragments of them are usually present, and this indicates that the spherulites are larger in some beds than in others. Quartz usually constitutes about 90 per cent of the .1 to .25 millimeter grade; tourmaline crystals are rather common but constitute less than one percent of the residual grains; and a few crystals of rutile and zircon are found. The silt grade is more than 99 per cent quartz, and the remainder consists of tourmaline, rutile, and zircon. All grains are stained with iron oxide, and about 10 per cent of them are cemented into aggregates which did not break down. Most of the iron oxide was lost in the mud grade. A few of the quartz grains are opaque, some of the larger ones are glazed, but most of them are transparent. Inclusions of rutile are common in the quartz.

All of the quartz grains having a diameter greater than .25 millimeter are well rounded, most of the grains between .25 and .1 millimeter are slightly rounded to angular, and those smaller than .1 millimeter are angular. All of the tourmaline, rutile, and zircon show characteristic crystal forms without evidence of wear.

Spherulites. As stated above, the spherulites form a considerable portion of these strata, but they do not occur in the same abundance in all the beds. Those in the lower beds, and particularly in the less indurated strata, are stained brown by iron oxide and are siliceous; those in the upper or indurated beds are gray to yellowish brown and are calcareous.

When viewed through the microscope the individual spherulites look very much like roasted coffee berries for they have the same luster and color. They are circular to elliptical in outline and are usually flattened. They vary from .10 to .75 millimeter in diameter, but most of them measure about .50 millimeter across. They are built up in concentric layers which spall off in thin, shell-like pieces. Thin sections show that most of the layers are made up of tiny grains of quartz cemented by amorphous silica, but a few layers of crystalline quartz occur in some spherulites. They are stained throughout with limonite, but the central portion of many spherulites is more transparent than the outer. Near the center of some spherulites are irregular, opaque, black bodies whose composition has not been determined, and which may have served as nuclei about which the oolite grains were built. Scattered through the oolite grains but most abundant in the outermost layer are minute particles of a black substance. Apparently these particles represent foreign material that gathered on the surface of the spherulite and became embedded during its growth. Some of the grains of quartz in the matrix of the oolite extend into the spherulites but are not firmly cemented there.

Probably all the spherulites were originally calcareous, like those in the upper beds, but subsequent to the deposition of the oolitic beds, silica that was carried in solutions replaced the carbonate in the spherulite and in some of the cementing material of the matrix. At the same time also a considerable amount of iron and aluminum hydroxide was introduced. The position of the oolite just above the impervious Richmond shale would favor such reaction with ground-water. A similar change has frequently been noted in oolites.[15]

The mineral grains that are included in the spherulites are similar in composition and angularity to others that occur in the oolite matrix, but they are much smaller. This fact suggests that the spherulites were formed in place and were not transported. The fact that most of the spherulites are arranged with their greatest dimensions parallel to the bedding indicates that they probably are syngenetic in origin, that is, formed while the sediments were accumulating. The condition of occurrence and the character of the spherulites suggest also that they were formed from colloids in suspension. Bucher[16] states that "most oolites . . . were formed by at least one constituent substance changing from an emulsoid state to that of a solid; that the spherical shape of the grains is due to the tendency of the droplets . . .

Fig. 11. Essex limestone two miles east of Essex. Note the dip. The blue, shaly limestone outcrops just above the water's edge. During dry seasons Richmond shale is exposed in the creek bed.

to coalesce." The spherical shape is believed to be due to growth in suspension, the concentric structure depending on the rate at which another substance is enmeshed in the growing structure by surface tension. The factors determining the suspension, dispersion of the colloids, and the nature of the medium involve physical conditions such as the presence of protective colloids; chemical conditions such as the nature and quality of other substances in solution; and perhaps biological factors, including the action of bacteria. The

[15] Brown, T. C., Origin of oolites and the oolitic texture in rocks: Bull. Geol. Soc. America vol. 25, pp. 759-768, 1914.

Barbour, E. H., and Torrey, J., jr., Notes on the microscopic structure of oolite, with analyses: Am. Jour. Sci., 3d ser., vol. 40, pp. 246-249, 1890.

[16] Bucher, W. H., On oolites and spherulites: Jour. Geology, vol. 26, pp 593-609, 1918.

region was apparently submerged to a very slight depth at the time of deposition of the oolite and there were probably numerous areas of quiet waters in protected or partically enclosed arms of the embayment, in which the oolite could develop.

ESSEX LIMESTONE MEMBER

The name "Essex" is applied to all Edgwood strata in the Herscher quadrangle except the Noix oolite. The name was first used in a description[17] of Edgwood strata that crop out along Horse Creek two miles east of Essex. (See figs. 11 and 12.) No outcrops of Essex limestone occur north of Kankakee River in the Herscher quadrangle. In no outcrop are both the Noix oolite and the Essex limestone exposed. Locally the beds of Essex limestone dip 22° southeast, but elsewhere they lie more nearly flat.

Fig. 12. A close view of the Essex limestone. Blue, nonfossiliferous, shaly beds outcrop at the water's edge.

Just south of the bridge over Horse Creek two miles east of Essex the following strata are exposed:

	Thickness Feet	Inches
Edgewood formation		
Essex member (lower portion)		
Limestone, yellowish-brown, very fossiliferous, ferruginous; in beds 1 to 5 inches thick interstratified with soft, shaly limestone in thin layers	7	..
Limestone, blue, shaly, thin-bedded; contains few fossils	..	8–12
Limestone, light brown, shaly, contains few fossils; grades into a hard, massive, bluish-gray limestone to the east	..	8–36
Richmond shale		

17 Savage, T. E., The Channahon and Essex limestones in Illinois: Trans. Illlinois Acad. Sci., vol. 4, 1912.

Twenty rods upstream the following section is exposed:

	Thickness Feet	Inches
Kankakee formation		
Dolomite, yellowish-brown, cherty bed at base contains *Platymerella manniensis*	3	6
Edgewood formation		
Essex member (upper portion)		
Limestone, magnesian, yellow, shaly; beds 1 to 4 inches thick; contains very few fossils	6	..
Limestone, blue, hard, shaly, nonfossiliferous; beds 2 to 8 inches thick	4	..

The strata in the first outcrop are known to be stratigraphically lower than those in the second outcrop because when they are traced horizontically they pass under the second outcrop.

A quarry 30 rods southwest of the exposure that is described above exposes bluish, thin-bedded, shaly, very "rotten" limestone, which is almost identical in appearance and fossil content with the Edgewood strata that occur west of Custer Park.

The Edgewood strata that crop out in the bluffs of Horse Creek near the road a quarter of a mile west of Custer Park are typical of the shaly limestone phase of the Essex member. They comprise the following section:

	Thickness Feet	Inches
Edgewood formation		
Essex member		
6. Limestone, yellowish-brown, moderately hard; beds 1 to 4 inches thick; contains few fossils	2	..
5. Limestone, yellowish-brown, earthy, nonfossiliferous	1	..
4. Limestone, yellowish-brown, shaly, soft; beds 1 to 3 inches thick; contains few fossils	5	..
3. Limestone, blue, shaly; weathers yellowish-brown; conchoidal fracture; uneven beds; full of poorly preserved fossils, mostly casts	5	..
2. Shale, dark brown, slightly calcareous; surface weathers black; contains a few poorly preserved fossils	1	3
1. Shale, calcareous, alternate light brown and reddish-brown beds ¼ inch thick; brittle and harder than the underlying Richmond shale	..	4

These strata have been considerably weathered and are shattered by joints, which are filled with clayey residuum. The beds locally dip 20° southeast, but to the west they are horizontal. The same strata crop out at the cross-roads in the southeast part of sec. 13, T. 32 N., R. 9 E.

The easternmost outcrop of Edgewood strata in the Herscher quadrangle occurs in the south bank of Kankakee River, in the western part of sec. 36, T. 32 N., R. 10 E., where the following section of Essex strata is exposed:

	Thickness Feet	Inches
Dolomite, yellowish-brown, nonfossiliferous, harder than typical Essex limestone; beds are thin and uneven, few being as much as 3 inches thick..	5	3

This dolomite grades without apparent break into the overlying Kankakee dolomite, which contains *Platymerella manniensis* and a few unidentifiable fossils. It rests unconformably on Richmond shale. The strata are decidedly unlike those west of Custer Park.

The yellowish-brown color of the Essex limestone is only a result of weathering, because the center portions of the thicker and more resistant beds are blue, and beds that are yellowish-brown at the surface have retained their blue color below the water-line. The blue limestone that is found in wells between Essex and Buckingham has been therefore mapped as Edgewood.

Although fossils are abundant in the Essex limestone. most of them are poorly preserved interior casts so that their identification is difficult and not always satisfactory. The following fossils were collected from the outcrop along Horse Creek two miles east of Essex:

Cornulites sp.
Cornulites distans Hall
Tentaculites oswegoensis
Favosites niagarensis Hall
a Lyellia cf. thebesensis Foerste
a, b Zaphrentis stokesi Edwards and Haime
a, b Zaphrentis subregularis Savage
b Atrypa sp.
a Atrypa putilla (Hall and Clarke)
Camarotoechia sp.
Camarotoechia obtusiplicata (Hall)
Camarotoechia cf. neglecta-cliftonensis Foerste
a, b Dalmanella edgewoodensis Savage
Dalmanella elegantula Dalman
cf. Gypidula sp.
Hebertella cf. fausta Foerste
Homoeospira sp.
Homoeospira apriniformis Hall
a Homoeospira subcircularis Savage
a, b Leptaena rhomboidalis (Wilckens)
b cf. Pholidops subelliptica Savage
b Rhipidomella hybrida (Sowerby)
Rhynchonella plicatella (Hall)

Rhynchonella whitei-praecursor (Foerste)
Rhynchotreta cf. cuneata (Hall)
b Rhynchotreta cf. intermedia Savage
a Rhynchotreta parva Savage
Rhynchotreta simplex Foerste
a Rhynchotreta thebesensis Foerste
a Rhynchotreta thebesensis multistriata Savage
Schuchertella sp. (2)
Schuchertella cf. subplana (Conrad)
Whitfieldella sp. (2)
a, b Whitfieldella ovoides Savage
Whitfieldella cf. nitida Hall
Whitfieldella cf. speciosa Savage
Bellerophon cf. opertus Foerste
Cyclora alta Foerste
a Lophospira fasciata Savage
a cf. Lophospira thebesensis Savage
Loxonema sp.
Pleurotomaria sp.
Strophorallus cf. incarinatum Foerste
Amphicoelia neglecta McChesney
Avicula sp.
Cymatonota? sp.
Ischyrodonta? sp.
Modiolopsis sp.
Modiolopsis primigenius (Conrad)
Modiolopsis subrhomboidea Simpson
Mytilarca cf. acutirostra (Hall)
Mytilarca mytiliformis (Hall)
Palaeanatina? sp.
a, b Pterinea sp. (2)
Conularia sp.
Algae?

The following fossils were collected from the outcrop west of Custer Park:
Tentaculites sepularius Hall
a Atrypa putilla (Hall and Clarke)
Camarotoechia sp.
Pholidops cf. sub-elliptica Savage
b Rhipidomella hybrida (Sowerby)
Rhynchotreta simplex Foerste
Schuchertella sp.
Whitfieldella sp.
Dalmanites cf. danai Meek and Worthen
Algae?

In addition the following species from the Essex limestone have been reported:[18]

[18] Savage, T. E., The Channahon and Essex limestones in Illinois: Trans. Illinois Acad. Sci., vol. 4, 1912.

—Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 351-376, 1913.

—Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, pp. 305-324, 1916.

a Halysites catenulatus Linnaeus
Atrypa marginalis (Dalman) ?
Camarotoechia near acinus Hall
b Rhynchotreta lepida Savage
Whitfieldella cf. cylindrica Hall
a, b Diaphorostoma sp.
Eurypterus pumilus Savage

The letter *"a"* before the name of any fossil in the above lists indicates that the fossil has been found also in the Edgewood formation of southwestern Illinois and Missouri, and the letter *"b"* indicates that the fossil has been found in the Channahon limestone, which is also a member of the Edgewood formation[19] and crops out along DesPlaines River, near Channahon, in the Wilmington quadrangle.

CORRELATION

The calcareous and siliceous oolitic shale that crops out along Kankakee River above Custer Park is called the Noix oolite because it occupies the same stratigraphic position and is lithologically similar to the Noix oolite member of the Edgewood formation in Missouri. In the Herscher quadrangle the oolite occurs just below but separated from the Kankakee (Sexton Creek) limestone by a break in sedimentation, and it is near other beds that have similar relations to the Kankakee formation and that are considered to be Edgewood strata. The Noix oolite both in Missouri and in the Herscher quadrangle is siliceous, but in Missouri it contains fossils and in the Herscher quadrangle it does not.

The Noix oolite in the Herscher quadrangle is believed to be a shallow-water equivalent of and was probably deposited contemporaneously with the lowest, blue, nonfossiliferous phase of the Essex limestone. If this be true, it seems that while the upper portion of the Essex limstone was being deposited elsewhere, there was little if any deposition of any kind in the localities where the oolite occurs. However, it is possible that the oolite is older than any part of the Essex limestone, and all but local remnants of it was eroded while the Essex limestone was being deposited. The first explanation seems more reasonable because the local distribution of the oolite might be expected if the oolite were a littoral deposit.

Although the Essex and Kankakee limestones are apparently conformable in every respect, they can be satisfactorily separated by reference to a thin zone in which a fossil brachiopod, *Platymerella manniensis,* is abundant. The *Platymerella* zone is considered to mark the bottom of the Kankakee limestone because it occurs at the base of the Sexton Creek formation in southwestern Illinois and Missouri, where the Edgewood and Sexton Creek

[19] Savage, T. E., The Channahon and Essex limestones in Illinois: Trans. Illinois Acad. Sci. vol. 4, 1912.

formations are reported[20] to be unconformable, and because it occurs just above the unconformity between the Noix oolite and Kankakee limestone in the Herscher quadrangle.

The Essex limestone near Essex and the Edgewood strata in the bluffs of Horse Creek just west of Custer Park are probably of the same age, because they bear the same relations to the *Platymerella* zone, the upper portions of both outcrops contain few, if any, fossils, and the lower portions contain similar fossils. The Edgewood strata below the *Platymerella* zone in the outcrop in the south bank of Kankakee River, in the west part of sec. 36, T. 32 N., R. 10 E., are similar and probably equivalent in age to the upper strata of the Essex limestone near Essex. As the Edgewood strata in the outcrop along Kankakee River are apparently conformable with the overlying beds, they may be equivalent to the hiatus between the Edgewood and Sexton Creek formations in southwestern Illinois and Missouri, and if this be true, the uppermost portion of the Essex limestone is younger than any of the southern Edgewood and is therefore the youngest Edgewood known.

The fauna of the Essex limestone in the Herscher quadrangle and of the Edgewood formation in southwestern Illinois and Missouri have many characters in common. Of the 62 species of fossils listed from the Edgewood formation,[21] at least 17 have been found in the Essex limestone, and for most of the other species in either province there is a closely related form in the other, so that the faunal difference is not so marked as the figures alone indicate. Fossil trilobites are rare in the Essex strata, and the fossil pelecypods which are found in great abundance in the Essex limestone are less numerous in the Edgewood formation in southwestern Illinois and Missouri. Differences of this nature might be expected, as the strata in the two localities were deposited on opposite sides of a large embayment which is believed to have covered most of Illinois during Edgewood times.

The lithology and fauna of the Essex limestone in the Herscher quadrangle are similar to those of the Channahon limestone in the Wilmington

---

20 Savage, T. E., On the Lower Paleozoic stratigraphy of southwestern Illinois: Am. Jour. Sci., 4th ser., vol. 25, pp. 435 and 443, 1908.

—The Ordovician and Silurian formations in Alexander County, Illinois: Am. Jour. Sci., 4th ser., vol. 28, p. 518, 1909.

—The faunal succession and the correlation of the pre-Devonian formations of southern Illinois: Illinois State Geol. Survey Bull. 16, pp. 335-336, 1910.

—The relations of the Alexandrian series in Illinois and Missouri to the Silurian section of Iowa: Am. Jour. Sci., 4th ser., vol. 38, pp. 32-33, 1914.

21 Savage, T. E., Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 365-366, 1913.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, pp. 82-83, 1917.

quadrangle, which has been also called Edgewood on paleontological grounds.[22] The lower, fossiliferous portion of the Essex limestone is the equivalent of the Cyrene member and the upper, nonfossiliferous portion is the equivalent of the Bowling Green member of the Edgewood formation in southwestern Illinois and Missouri.[23]

KANKAKEE FORMATION

The name "Kankakee" was first applied[24] to the Alexandrian strata lying above the Edgewood formation in northeastern Illinois in order to differentiate them from the Sexton Creek formation in southwestern Illinois and Missouri, with which they are equivalent and by which they had been formerly designated.[25] The Kankakee formation is equivalent to the Brassfield ("Ohio Clinton") of Ohio, Indiana, and Kentucky,[26] and to the Gun River forma-

---

22 Savage, T. E., The faunal succession and the correlation of the pre-Devonian formations of southern Illinois: Illinois State Geol. Survey Bull. 16, pp. 334-335, 1910.

—The Channahon and Essex limestones in Illinois: Trans. Illinois Acad. Sci., vol. 4, 1912.

—Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 368, 369, 1913.

—The relations of the Alexandrian series in Illinois and Missouri to the Silurian section of Iowa: Am. Jour. Sci., 4th ser., vol. 38, pp. 32-33, 1914.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, p. 85, 1917.

23 Savage, T. E., The relations of the Alexandrian series in Illinois and Missouri to the Silurian section of Iowa: Am. Jour. Sci., 4th ser., vol. 38, pp. 32-33, 1914.

24 Savage, T. E., Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, p. 316, 1916.

25 Savage, T. E, Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 371-375, 1913.

—The relations of the Alexandrian series in Illinois and Missouri to the Silurian section of Iowa: Am. Jour. Sci., 4th ser., vol. 38, pp. 31-33, 1914.

—Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, pp. 306-307, 1916.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, pp. 89-91, 1917.

—Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 518-521, 1926.

26 Savage, T. E., On the Lower Paleozoic stratigraphy of southwestern Illinois: Am. Jour. Sci., 4th ser., vol. 25, pp. 435, 442, 1908

—The Ordovician and Silurian formation in Alexander County, Illinois: Am. Jour. Sci., 4th ser., vol. 27, p. 518, 1909.

—The faunal succession and the correlation of the pre-Devonian formations of southern Illinois: Illinois State Geol. Survey Bull. 16, pp. 336-341, 1910.

—Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 351-376, 1913.

—The relations of the Alexandrian series in Illinois and Missouri to the Silurian section of Iowa: Am. Jour. Sci., 4th ser., vol 38, pp. 28-37, 1914.

—Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, pp. 315-316, 1916.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, pp. 68-94, 1917.

—Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 514-521, 527-529, 533, 1926.

tion[27] in the famous section of Paleozoic strata that are exposed on Anticosti Island, in the Gulf of St. Lawrence.

The contact of the Kankakee and Edgewood formations has already been described. The contact of the Kankakee and Niagaran formations in the Herscher quadrangle occurs about 8 inches above a zone in which the fossil brachiopod *Stricklandinia pyriformis* is abundant, and is marked by a unique surface which is present at every outcrop at which the contact is exposed in the Herscher, Wilmington, and Joliet quadrangles. Except for small sinuous pits, which are probably the result of solution, this surface is as plane as though it had been smoothed with a mason's trowel. (See fig. 13.) The strata above the smooth surface have a slightly different mineral content from those below, having especially a larger amount of secondary marcasite and

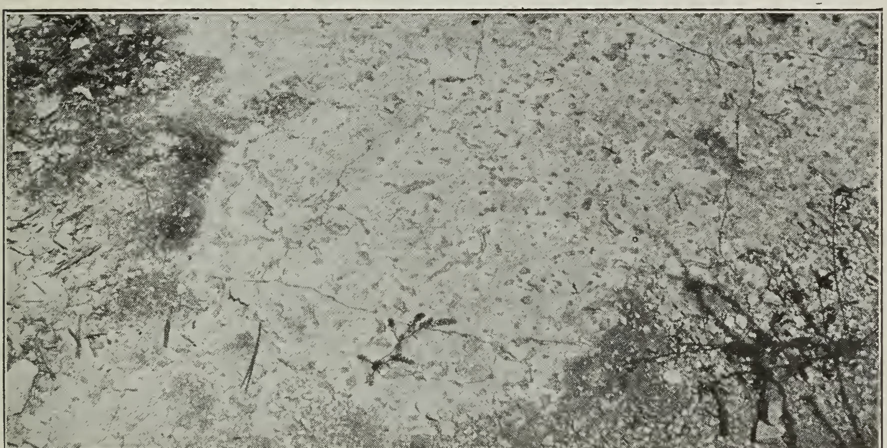


Fig. 13. Looking down on the smooth surface which marks the Niagaran-Kankakee contact. Note the small pits.

pyrite. They also lack coarse residual grains such as are found in the lower strata. (See mechanical analyses of Kankakee and Niagaran dolomites, pages 50 and 56.) These facts suggest a change in conditions of sedimentation and support the opinion that the surface marks the Kankakee-Niagaran contact. It represents a break in sedimentation, but its origin and full significance are not known.

The Kankakee formation consists of a light gray to yellowish or reddish-brown dolomite. It is a relatively pure carbonate rock quite like the overlying Niagaran dolomite and very unlike the Edgewood formation. It is not oolitic, but in places it is considerably iron-stained and contains numerous pyrite

27 Savage, T. E., Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, pp. 312-316, 1916.

grains. The texture varies from coarsely crystalline to dense, and in places it is porous and vesicular. Most of the rock is hard, tough, and difficult to break. Where it is hard and yellow the rock emits a sulfurous odor when struck with a hammer.

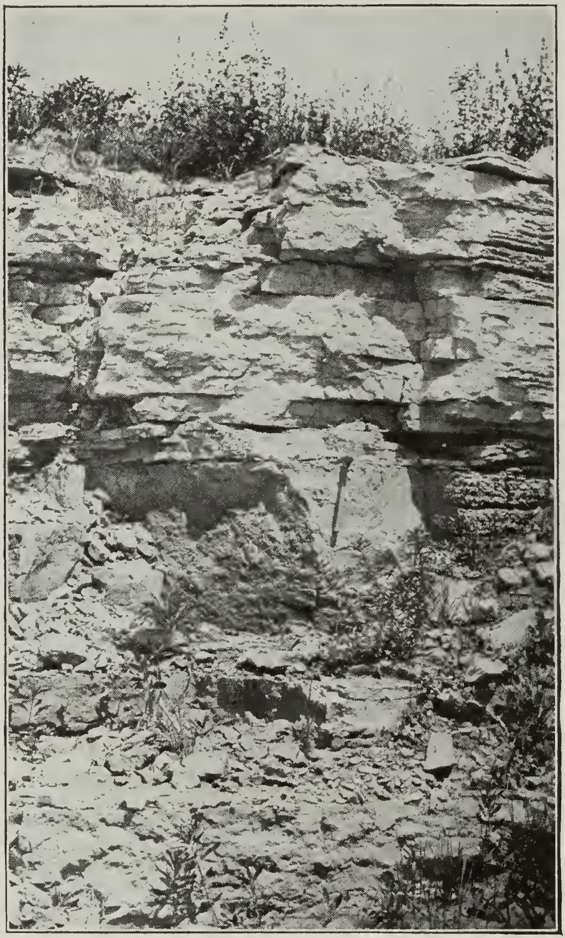


Fig. 14. Niagaran-Kankakee contact, marked by the head of the hammer, in Cowan's quarry, sec. 26, T. 32 N., R. 10 E. Note the massive beds in the Kankakee formation.

The thickness of the formation varies considerably; the observed minimum is 13 feet, and the maximum is more than 21 feet. Most of the beds are a few inches thick, but beds 3 or 4 feet thick do occur. They are continuous but have a corrugated appearance because they are irregular and uneven and are affected by horizontal joints. They lie so nearly horizontal that whatever local dips occur are practically negligible.

The Kankakee formation, exposed along both sides of Kankakee River in secs. 26, 35, and 36 T. 32 N., R. 10 E., as far east as an old railroad grade

Fig. 15. Kankakee-Edgewood contact, marked by the head of the hammer, in Cowan's quarry, sec. 26, T. 32 N., R. 10 E. The two types of bedding are characteristic of the Kankakee.

that lies just west of the Kankakee-Will county line, is a brownish, vesicular dolomite which in general is very tough and hard and fractures with a smooth, even surface. Everywhere *Stricklandinia pyriformis*, with which *Pentamerus oblongus* is associated in some places, occurs in a zone 8 inches below the top of the formation. Usually another zone containing *Pentamerus oblongus* and *Zaphrentis* casts occurs about 3 feet below the *Stricklandinia* zone. Along the south side of the river in sec. 36, *Platymerella* and *Zaphrentis* casts and one to three thin, discontinuous chert beds in which *Platymerella manniensis* is abundant occur in the lower 4 feet of the formation.

Cowan Brothers' quarry in the central part of sec. 26, T. 32 N., R. 10 E., exposes the following strata (figs. 14 and 15):

	Thickness Feet	Inches
Niagaran formation		
25. Dolomite, dense to fine-grained, hard; contains a few fossils	5	6
Kankakee formation		
24. Dolomite, grayish-brown, coarsely crystalline, fossiliferous; beds 3 to 8 inches thick; joints filled by yellowish-green clay; fossils include *Stricklandinia pyriformis* and *Pentamerus oblongus*	3	6
23. Dolomite, gray, dense to finely crystalline, hard; thin, uneven beds; few fossils	6	..
22. Dolomite, brown, dense, hard; regular beds, 2 to 6 inches thick; some thin beds highly ferruginous; contains a few *Zaphrentis*	3	1
21. Dolomite, ferruginous; surface coated with iron oxide; contains casts of *Platymerella manniensis*	..	5
Edgewood formation		
Shale, dolomitic, oolitic, massive, ferruginous	..	..

The above section reveals the variety of color and bedding in the Kankakee formation. There is a pronounced difference in color at the Niagaran-Kankakee contact, but it is of no value for correlation because similar differences occur within the Kankakee formation.

The following strata are exposed in a ravine along the north bluff of Kankakee River in sec. 26, T. 32 N., R. 10 E., half a mile southeast of Cowan's quarry:

	Thickness Feet	Inches
Kankakee formation		
Dolomite, light yellowish-brown, coarsely crystalline and hard at top; sulphur-yellow, finely crystalline and brittle at bottom; vesicular; contains scattered grains of pyrite; *Stricklandinia pyriformis* and *Pentamerus oblongus* in zone 8 inches below top as usual	14	..
Dolomite, dark brown, crystalline, hard, highly ferruginous; contains *Platymerella manniensis* and other fossils	2	4
Edgewood formation (shaly)		..

The unusual appearance of the Kankakee dolomite in this outcrop is probably due principally to weathering.

The uppermost strata of the Kankakee formation are exposed in a quarry on the north side of the road, in the center of the south side of sec. 23, T. 32 N.,

R. 10 E. The beds contain *Stricklandinia pyriformis, Pentamerus oblongus,* and fossils common in the Kankakee formation.

A complete section of hard, very slightly weathered Kankakee dolomite occurs in the north bluff of Kankakee River in sec. 27, T. 32 N., R. 10 E.

	Thickness Feet	Inches
Niagaran formation		
15. Dolomite, gray, crystalline, hard	..	..
Kankakee formation		
14. Dolomite, light yellowish-brown to gray, crystalline, highly fossiliferous; thin beds; *Stricklandinia pyriformis* zone 8 inches below top, *Pentamerus oblongus* zone 3 feet lower	15	3
13. Dolomite, gray to yellowish-brown, subscrystalline, very hard, nonfossiliferous; regular beds 2 to 6 inches thick; iron-stained	2	3
12. Dolomite, hard, highly ferruginous; weathered surfaces coated with limonite; contains poorly preserved casts of *Platymerella manniensis*	..	4
Edgewood formation (for details see page 33)		
Shale, dolomitic, oolitic, ferruginous	8	2

The beds of the Kankakee formation are uneven and have a wavy, corrugated appearance. Most of them are continuous, but some of them "pinch out". Some of the horizontal joints that affect the rock are so developed by weathering on the exposed surface that they converge and cause the beds to appear discontinuous.

The following strata outcrop along a ravine on the south side of Kankakee River, in sec. 27, T. 32 N., R. 10 E.:

	Thickness Feet
Niagaran formation	
Dolomite, yellowish, thin-bedded	15±
Kankakee formation	
Dolomite, yellowish-gray, very hard, very slightly weathered; regular, massive beds; *Stricklandinia pyriformis, Pentamerus oblongus* and *Zaphrentis* sp. occur in a zone 8 inches below top	21

Similar Kankakee strata occur in another ravine on the south side of the river, in the east part of sec. 28, T. 32 N., R. 10 E.

At Wesley-on-the-Kankakee along the east side of sec. 19, T. 32 N., R. 10 E., 15 feet of brownish, coarsely crystalline, hard, vesicular Kankakee dolomite, in beds 2 to 8 inches thick, outcrops along the north bluff of Kankakee River. A narrow zone containing *Stricklandinia pyriformis* and *Pentamus oblongus* occurs less than 6 inches below the top of the exposure. A zone containing only *Pentamerus oblongus* occurs 4 feet lower. Richmond shale is exposed near the water's edge, but if any Edgewood formation is present it is concealed by talus.

Kankakee strata similar to those exposed in the ravines on the south side of Kankakee River in secs. 27 and 28 are exposed in a quarry along the east side of Terry Creek, in the southeast part of sec. 29, T. 32 N., R. 10 E. Fresh Kankakee and Niagaran dolomite is exposed in a ditch in secs. 2 and 3, T. 31 N., R. 10 E. The color, texture, and hardness of the strata in both formations are similar and both formations contain a considerable amount of pyrite. The color of the unweathered rock is bluish-gray to nearly white; the weathered rock is dark brown. The zone containing *Stricklandinia pyriformis* and *Pentamerus oblongus* occurs 8 inches below the contact of the two formations.

The most southern outcrop of the Kankakee formation in the Herscher quadrangle overlies the Edgewood strata along Horse Creek two miles east of Essex. It is represented by a maximum thickness of 3½ feet of yellowish-brown dolomite in which there are nodules and thin lenses of chert which contain *Platymerella manniensis* and other fossils.

TABLE 5—*Mechanical analyses of the Kankakee dolomite (in per cent of the total sample by weight)*

Sample	Soluble material	Residue					
		Total	Coarse sand 1-.5 mm.	Medium sand .5-.25 mm.	Fine sand .25-.1 mm.	Silt .1-.01 mm.	Mud .01 mm.
No. 12	89.8	10.2	.20	.35	3.10	3.65	2.90
No. 13	90.05	9.95	.05	.70	1.05	2.35	5.80
No. 14	93.4	6.60	.05	.30	.45	1.95	3.85
No. 24a	94.25	5.75	.05	.40	.55	2.10	2.65
No. 24b	93.5	6.50	.10	.45	.70	1.90	3.35
Average	92.2	7.8	.09	.45	1.17	2.39	3.71

Samples Nos. 12, 13, 14 (Table 5) are from identically numbered beds in the outcrop along the north bluff of Kankakee River, in sec. 27, T. 32 N., R. 10 E., described on page 49. Sample No. 24a is from the very top of the Kankakee formation in Cowan Brothers' quarry, and Sample No. 24b was taken 2 feet below 24a.

The results of the analyses indicate that the bottom bed of the Kankakee formation contains a larger percentage of residual minerals, or, in other words is more shaly, than the beds higher stratigraphically. Thus the Kankakee dolomite becomes more nearly pure toward the top of the formation.

Most of the residual material is quartz. Perhaps 95 per cent of the sand grades of the residues are rounded to subangular quartz grains, and 1 to 5 per cent are pyrite and marcasite; there are also a few nodules of iron oxide. The silt and mud grades consist of 99 per cent quartz and contain a few crystals of zircon and rutile; a few grains of pyrite and marcasite are also present in the silt grade. The pyrite, marcasite, and iron oxide are secondary minerals. Marcasite and pyrite, both secondary minerals, are the only minerals found in the Kankakee formation and not in the Edgewood formation, whereas tourmaline was found in the Edgewood and not in the Kankakee formation.

As noted in the descriptions of outcrops, a zone in which *Stricklandinia pyriformis* is abundant occurs 8 inches below the top of the Kankakee formation at all exposures. *Clathropora frondosa, Rhinopora* near *verrucosa,* and *Zaphrentis* sp. are commonly found in the same zone. In some places *Pentamerus oblongus* is also found in the same zone, but it is more commonly found in some abundance in a zone about 3 feet lower.

The following fossils were collected from the Kankakee strata along Kankakee River between Custer Park and the Kankakee-Will county line:

a, b Halysites catenulatus Linnaeus
a Zaphrentis sp.
b Clathropora frondosa Hall
a, b Rhinopora cf. verrucosa Hall
a, b Atrypa marginalis (Dalman)?
a Clorinda sp.
a Dalmanella sp.
a, b Leptaena rhomboidalis (Wilckens)
a, b Orthis flabellites Foerste
a Pentamerus sp.
a Pentamerus oblongus Sowerby
a Platymerella manniensis Foerste
a, b Platystrophia daytonensis Foerste
a, b Platystrophia reversata Foerste
a, b Plectambonites transversalis var. elegantula Foerste
b Plectambonites transversalis var. prolongata Foerste
a Schuchertella sp. (2)
Schuchertella subplana (Conrad)
a Stricklandinia sp.
Stricklandinia pyriformis Savage
Stricklandinia pyriformis var. varicosa Savage
a Whitfieldella sp.
Bellerophon sp.
a, b Cyclonema daytonensis Foerste
a Diaphorostoma niagarensis (Hall)
cf. Murchisonia sp.
a Orthoceras sp. (2)
a Illaenus sp.
a Illaenus madisonianus Whitfield

In addition, the following fossils have been reported from the Kankakee formation in northern Illinois:[28]

a Alveolites sp.
Chonophyllum sp.
a Clathrodictyon vesiculosum Nicholson and Murie
a Diphyphyllum caespitosum (Hall)
a Favosites favosus (Goldfuss)
a Favosites niagarensis (Hall)
a Heliolites sp.
a Lyellia sp.
a Syringolites huronensis (Hinde)
a Syringopora sp.
a Syringostroma sp.
a Thecia sp.
a Atrypa reticularis (Linnaeus)
a Atrypa sp.
a Bilobites sp.
a Callopora sp.
a Camarotoechia acinus var. convexa Foerste
a Camarotoechia whitei cf. var. praecursor Foerste
a Clorinda transversa (Savage)
a Dalmanella elegantula (Dalman)
a Dinobolus sp.
Hebertella fausta (Foerste)
Pachydictya sp.
a Phoenopora cf. ensiformis (Hall)
Phoenopora sp.
Rhinopora verrucosa
a Rhinopora sp.
a Schuchertella tenuis (Hall)
Stricklandinia breviuscula Savage
a Stricklandinia circularis Savage
a Stricklandinia pyriformis var. elongata Savage
Stricklandinia pyriformis var. vasculosa Savage
a Stricklandinia triplesiana (Foerste)
a Stropheodonta (Brachyprion) sp.
a Strophonella filistriata (Foerste)
a Strophonella daytonensis (Foerste)
a Triplecia ortoni (Meek)
a Amphicoelia leidyi (Hall)
Hormotomia cf. subulata (Conrad)
a Straparollus sp.
a Bronteus acamus (Hall)
Calymene niagarensis (Hall)
a Calymene vogdesi (Foerste)

---

28 Savage, T. E., Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 372-373, 1913.

—Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, pp. 317-319, 1916.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, pp. 90-91, 1917.

—Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 520-521, 1926.

a Ceraurus cf. niagarensis Hall
a Encrinurus sp.
a Goldius sp.
a, b Illaenus ambiguus (Foerste)
a Illaenus daytonensis (Foerste)
Metapolichas sp.

The letter *"a"* in the above lists indicates that the fossil has been also reported from the Sexton Creek limestone in southwestern Illinois,[29] and the letter *"b"* indicates that the fossil has been reported from the Brassfield formation of southern Indiana.[30]

The preceding lists of fossils show that the fauna of the Kankakee limestone is very similar to that of the Sexton Creek limestone in southwestern Illinois, and the two fauna are considered contemporaneous.[31] It is less similar to the fauna of the Brassfield formation in southern Indiana, but many genera not included in the lists are common to both localities, and many species that occur in either locality are closely related to those that occur in the other locality. The fauna of the Kankakee limestone is less closely allied with that of the Brassfield formation in Ohio, probably because the Cincinnati structural arch formed a land barrier between the two regions and prevented free intermigration of the various forms. Furthermore, the fauna of the Alexandrian series in Illinois originated earlier and continued later than the corresponding fauna in Ohio.[32]

NIAGARAN SERIES

The Niagaran series in Illinois, which consists almost wholly of dolomitic limestone, was formerly considered a single formation, but it has been recently divided into four formations.[33] Presumably all of the Niagaran strata in the Herscher quadrangle belong to the lowest of the four formations, the Joliet limestone, as the rock quarried by the Lehigh Stone Company in sec. 7, T. 14 W., R. 30 N. along the east edge of the quadrangle is assigned to the Joliet formation.[34] (See fig. 16.) However, as the Niagaran series was not differentiated during the field work for this report, the term "Niagaran dolomite" is used here as a formation name.

29 See references cited on p. 52 and: Savage, T. E., On the Lower Paleozoic stratigraphy of southwestern Illinois: Am. Jour. Sci., 4th ser. vol. 25, pp. 431-443, 1908.

—The Ordovician and Silurian formations in Alexander County, Illinois: Am. Jour. Sci., 4th ser., vol. 28, pp. 509-519, 1909.

30 Culbertson, J. A., The Brassfield formation of Jefferson County, Indiana, presented as a master's thesis at the University of Chicago, 1924.

31 and 32 Savage, T. E., Alexandrian series in Missouri and Illinois: Bull. Geol. Soc. America, vol. 24, pp. 351-376, 1913.

—Stratigraphy and paleontology of the Alexandrian series in Illinois and Missouri: Illinois State Geol. Survey Bull. 23, p. 91, 1917.

33 Savage, T. E., Silurian rocks in Illinois: Bull. Geol. Soc. America, vol. 37, pp. 513-534, 1926.

34 Idem, p. 522.

NIAGARAN DOLOMITE

The Niagaran dolomite includes all strata between the Kankakee formation and the Pennsylvanian system in the Herscher quadrangle. It underlies the east half of the quadrangle, and its thickness increases eastward from the west margin of its areal distribution. The maximum known thickness in the Herscher quadrangle is 125 feet, at Lehigh. Just north of Kankakee River at the Kankakee-Will County line the Niagaran strata are at least 60 feet thick.

The formation consists of dolomitic limestone. The characteristic color of the rock is gray with a faint bluish tint, but there are some streaks of pink. Where the rock is weathered, its color varies from a dirty gray through

Fig. 16. Niagaran beds near the top of the face at Lehigh Stone Company quarry, sec. 7, T. 30 N., R. 14 W.

yellowish-brown to dark brown. The texture of the rock is usually coarsely crystalline, and crystals more than two millimeters in diameter occur in some places, but dense, microcrystalline rock is not uncommon. In places the rock is vesicular. As a rule it is hard and tough and breaks with a smooth fracture. The beds are even and continuous and range from one or two inches to three feet in thickness. Fossils are sparsely scattered throughout the formation, but well-preserved specimens may occur in some abundance locally. Pyrite grains, most of which are less than 25 millimeters in diameter, are profusely scattered through the rock, which stains readily as a consequence. The pink streaks indicate the presence of manganese.

The Niagaran dolomite crops out in many places in the northeast part of the quadrangle. It is almost continuously exposed along either side of Kankakee River as far west as sec. 28, T. 32 N., R. 10 E., and over a large area in the vicinity of Lehigh, where it practically forms the surface of parts of secs. 1, 11, and 12, T. 30 N., R. 10 E., parts of secs. 6, 7, and 18, T. 30 N., R. 11 E., parts of secs. 6, 7, and 18, T. 30 N., R. 14 W., part of sec. 36, T. 31 N., R. 10 E., and part of sec. 31, T. 31 N., R. 11 E. Isolated outcrops occur in secs. 25 and 34, T. 32 N., R. 10 E., and secs. 2, 13, 25, and 27, T. 31 N., R. 10 E.

At Cowan Brothers' quarry, in sec. 26, T. 32 N., R. 10 E., 5 feet of Niagaran dolomite overlies Kankakee dolomite (fig. 14). The Niagaran dolomite effervesces freely in dilute hydrochloric acid, which shows that the rock has a high content of calcium carbonate. The rock is dense or minutely crystalline and breaks with an uneven fracture. The beds are regular and are 2 to 3 inches thick. There are relatively few fossils in the Niagaran strata. A 3-inch bed of brick-red, fossiliferous limestone occurs locally near the top of the outcrop.

Dark brown Niagaran dolomite in beds 1 to 14 inches thick is exposed along the Kankakee-Will county-line road, just north of the Warner bridge. The rock in this outcrop is darker than that at Cowan's quarry, probably because it is more weathered, for mechanical analyses show that the rocks in both localities have the same general constitution. (See table 6.)

Less than five feet of Niagaran dolomite is exposed in a quarry at Bonfield, in sec. 27, T. 31 N., R 10 E. The rock is gray when freshly broken but weathers light brown. It is vesicular and not very hard. The beds are even and continuous, and few exceed six inches in thickness.

More than 50 feet of Niagaran dolomite is exposed in the quarry of Lehigh Stone Company, in sec. 7, T. 30 N., R. 14 W. (fig. 16). The exact stratigraphic position of these beds is not known, but a test well 175 feet deep did not reach the Richmond shale. The upper, weathered portion of the exposed beds is like the weathered rock in the Bonfield quarry. The color of the rock is usually gray or bluish-gray, but pink manganese stain is conspicuous near the bottom of the exposure. Some beds are coarsely crystalline, but a dense, very fine texture is more common, and some of the strata are slightly vesicular. The rock is hard and tough and difficult to break with a hammer. The beds are even and continuous; near the top of the exposure they range from a fraction of an inch to 5 or 6 inches in thickness, but at the bottom of the quarry some of them are as much as 4 feet thick. Stylolites are common but are not conspicuous. The surface of the weathered rock, which in general extends not more than 8 feet below the ground, is reddish-brown in color and dotted with small grains of pyrite, which commonly cause a visible stain. Residual clay is present along some of the bedding-planes.

Sample No. 15 (Table 6) was taken from the outcrop along the Kankakee-Will county-line road north of the Warner bridge. Sample No. 25a was taken from the bottom of the Niagaran dolomite in Cowan's quarry, No. 25b 2 feet above No. 25a, and No. 25c 4 feet above 25a.

The analyses show that the residue of the Niagaran dolomite is very much finer grained than those of the Edgewood and Kankakee formations. The bulk of it is mud, a smaller amount is silt, a very small amount is medium sand, and there is no coarse sand.

The secondary minerals pyrite and marcasite are more abundant in the Niagaran dolomite than they are in the Kankakee formation. They comprise 5 to 10 per cent of the residual sand, and the remainder consists of rounded quartz grains. Perhaps 99 per cent of the residual silt consists of angular quartz grains, as there are only a few scattered crystals or grains of zircon, rutile, iron sulfides, ilmenite or chromite, and a rosin-colored mineral probably sphalerite.

Table 6—*Mechanical analyses of the Niagaran dolomite (in per cent of the total sample by weight)*

Sample	Soluble material (carbonates)	Residue					
		Total	Coarse sand 1-.5 mm.	Medium sand .5-.25 mm.	Fine sand .25-.1 mm.	Silt .1-.01 mm.	Mud .01 mm.
No. 15	95.2	4.8		.05	.70	1.00	3.05
No. 25a	88.1	11.9			.48	3.95	7.45
No. 25b	94.8	5.2			.55	1.00	3.65
No. 25c	92.75	7.25			.50	2.20	4.55
Average	92.7	7.3		.02	.56	2.04	4.67

Fossils are not numerous in the Niagaran dolomite along Kankakee River. *Calymene celebra* and *Dawsonoceras annulatum* are most common, and others are:

Favosites cf. favosus (Goldfuss)
Halysites catenulatus Linnaeus
Zaphrentis sp.
Atrypa reticularis Linnaeus
Camarotoechia sp.
Dalmanella elegantula (Dalman)
Leptaena rhomboidalis (Wilckens)
Stropheodonta profunda (Hall)
Aethocystites sp.

Bumastus imperator (Hall)
Illaenus sp.
Orthoceras simulator Hall
Protokionoceras medullare (Hall)

At the Bonfield quarry *Calymene celebra* is the most common of the few scattered fossils, among which the others are:

Zaphrentis sp.
Atrypa reticularis
Platyceras cornutum
Dalmanites platycaudalis
Leptaena rhomboidalis
Orthoceras sp.

Fossils are not plentiful in most of the rock at the Lehigh Stone Company quarry, but are locally abundant. *Calymene celebra* and various cephalopods occur throughout the rock. Nearly all the fossils in the following list were collected in a very limited area less than 5 feet below the top of the north wall of the quarry:

Zaphrentis sp.
Anastrophia internascens Hall
Atrypa reticularis (Linnaeus)
Atrypina disparilis (Hall)
Camarotoechia? sp.
Clorinda sp.
Cyrtia myrtia Billings
Leptaena rhomboidalis (Wilckens)
Lingula sp.
Merista pentlandica (Haswell) described as Rhynchonella
Nucleospira pisiformis Hall
Plectambonites transversalis (Wahlenburg)
Rhipidomella hybrida (Sowerby)
Spirifer radiatus Sowerby
Stropheodonta sp.
Stropheodonta profunda Hall
Strophonella sp.
Uncinulus stricklandi (Sowerby)
Eucalyptocrinus crassus Hall
Eucalyptocrinus inorantus Weller
Bellerophon sp.
Cyclonema elevata Hall
Pterinea sp.
Arctinurus occidentalis Hall
Bumastus graftonensis (Meek and Worthen)
Ceraurus niagarensis Hall
Cyphaspis sp.
Calymene celebra
Dalmanites cf. illaenoisensis Weller

Dalmanites verrucosus (Hall)
Dalmanites vigilans Hall
Dicranopeltis sp.
Illaenoides triloba Weller
Illaenus sp.
Illaenus cf. ioxus Hall
Dawsonoceras annulatum Sowerby
Kionoceras crebescens
Lituites cancellatum (McChesney)
Orthoceras sp.
Orthoceras simulator Hall
Protokionoceras medullare (Hall)

Pennsylvanian System

GENERAL DESCRIPTION

The strata in the Herscher quadrangle next younger than the Niagaran dolomite belong to the Pennsylvanian system and are included in the so-called "Coal Measures" of northeastern Illinois. The Pennsylvanian rocks of the State are divided into three formations—Pottsville, Carbondale, and McLeansboro.[35] Most of the Pennsylvanian strata in the Herscher quadrangle belong to the Carbondale formation. Some of the strata in the west part of the quadrangle may belong to the Pottsville formation, but this fact has not been demonstrated conclusively. It is also debatable whether or not any strata in the quadrangle belong to the McLeansboro formation.

The Pennsylvanian strata underlie about 45 square miles in the west one-fourth of the quadrangle. Their eastern boundary as shown on Plate II is only approximate, because surficial Pleistocene deposits prevent the determination of the precise boundary, and well logs provide the only data by which it can be located. Coal test borings are sufficiently numerous north of Buckingham that the boundary is reasonably accurate, but south of Buckingham the boundary is less accurate.

Little is known about the beds that underlie the Pennsylvanian strata in the quadrangle. In most places the "Coal Measures" are underlain by Richmond shale, but in some places along their eastern margin they are underlain by Silurian strata. These relations show that warping and erosion of the older beds preceded the deposition of the Pennsylvanian sediments.

The thickness of the Pennsylvanian beds ranges from a few feet along their eastern margin to more than 125 feet near the southwest corner of the quadrangle. This variation is due to a pre-Pennsylvanian structural depres-

---

35 Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

Shaw, E. W., Carlyle oil field and surrounding territory: Illinois State Geol. Survey Bull. 20A, pp. 15-16, 1912, and Bull. 20, pp. 68-69, 1915.

sion to the west, to irregularities in the pre-Pennsylvanian erosional surface, and to irregularities produced by post-Pennslyvanian erosion. As much as 10 feet of relief within short distances occurs on the pre-Pennsylvanian surface.

Correlation of the Pennsylvanian formations in the Herscher quadrangle is difficult because the only outcrops are a few small outliers which have no stratigraphic significance, no mines are open, and very few wells penetrate the total thickness of the system. For the same reasons the following generalized section of the Pennsylvanian strata in the region is based on well logs and on studies in mines at South Wilmington and Braidwood, respectively west and north of the quadrangle:

	Range in Thickness				
	Feet	*Inches*		*Feet*	*Inches*
McLeansboro? formation					
Sandstone	2	..	to	35	..
Shale (soapstone)	8	..	to	27	..
Coal No. 7	2	3	to	4	8
Shale (fire clay)	2	..	to	11	..
Limestone lenses	..	..	to	12	..
Carbondale formation					
Sandstone	3	..	to	69	..
Shale (soapstone), locally containing lenticular coals	10	..	to	41	..
Coal No. 2	2	6	to	3	3
Pottsville formation					
Shale, (fire clay)	3	6	to	6	..
Carbonaceous shale	1	2	to	4	..
Shale (fire clay)	..	10	to	2	6
Shale	3	9	to	7	1

The two coals in the above section occur so regularly that their continuity and correlation within the region is probably established, but their correlation with those of the rest of Illinois, as given by drillers, miners, and others, is questionable. The other strata are so variable and without apparent continuity that individual beds encountered in different borings and shafts can not be identified or correlated. The limestone stratum is known to be lenticular and occurs only in an area that lies west of the outcrop of No. 7 coal.

POTTSVILLE FORMATION

The Pottsville formation includes all Pennsylvanian beds in Illinois below the base of No. 2 coal.[36] The only available source of information concerning the Pottsville formation in the Herscher quadrangle is the logs of a few test wells which passed through No. 2 coal. North and northwest

[36] DeWolf, F. W., Studies in Illinois coal: Illinois State Geol. Survey Bull. 16, p. 180, 1910.

of the quadrangle is a considerable thickness of this formation.[37] In the Morris quadrangle a maximum thickness of 90 feet of Pottsville sediments[38] is recorded, but in the Herscher area the formation is thinner. The logs of all the test wells that penetrate strata below No. 2 coal record below the coal 8 to 13 feet of shale containing some carbonaceous layers. The city well at Braidwood, just north of the quadrangle, penetrated about 58 feet of shale, sandstone, and thin coals of Pottsville age, which probably extend into the northern part of the quadrangle. The Pottsville formation contains no workable coals in this area.

CARBONDALE FORMATION

The name Carbondale is applied to all beds of Pennsylvanian age in Illinois between the base of No. 2 coal and the top of No. 6 coal.[39] No. 6 coal is commonly identified by a thin layer of clay, known as the "blue band", that occurs in the lower part of the bed. This coal is also commonly associated with a limestone cap-rock of distinctive lithologic character. As no coal possessing a blue band or having a limestone cap-rock is present in the Herscher quadrangle, No. 6 coal is thought to be absent from the area. Accordingly, the position of the top of the Carbondale formation cannot be definitely placed, but it is thought to be below the coal which is here called No. 7, and is arbitrarily placed beneath the limestone lying 2 to 11 feet below No. 7 coal. On this basis the Carbondale formation includes No. 2 coal and the overlying shales, sandstones, and local coals, comprising a total of 35 to 80 feet of sediments.

MC LEANSBORO FORMATION

By definition[40] the McLeansboro formation includes all Pennsylvanian strata in Illinois above the Carbondale formation. Where No. 6 coal is present and can be recognized, it marks the top of the Carbondale formation. No. 7 coal lies near the base of the McLeansboro formation in places where both No. 6 and No. 7 coal seams are present. If the upper coal in the Herscher area is correctly identified as No. 7, No. 6 coal being absent, the base of the McLeansboro formation can not be definitely determined but will probably be not far below No. 7 coal. It has been stated in the preceding paragraph that this boundary is arbitrarily placed beneath the limestone lying 2 to 11 feet below No. 7 coal. According to this correlation the thickness

---

37 Culver, Harold E., Geology and mineral resources of the Morris quadrangle: Illinois State Geol. Survey Bull. 43, pp. 133-138, 1923.

Fisher, D. J., personal communication.

38 Culver, H. E., op. cit., p. 135.

39 Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 6, 1912.

Shaw, E. W., The Carlyle oil field and surrounding territory: Illinois State Geol. Survey Bull. 20A, p. 16, 1912, and Bull. 20, p. 69, 1915.

40 DeWolf, F. W., op. cit., p. 181.

of the McLeansboro formation in the Herscher quadrangle ranges from a few feet near the outcrop of No. 7 coal to about 80 feet near Reddick. The upper sandstone present in this area is thought to be the Waupecan sandstone of the Morris area.[41]

As pointed out by Culver,[42] this sandstone may be the only representative of the McLeansboro in the Morris and Herscher areas, or it may be the equivalent of the Vermilionville of LaSalle County, in which case it belongs in the Carbondale formation. If the latter correlation is correct the so-called No. 7 coal should be assigned a position between coals No. 2 and No. 5, and no McLeansboro strata exist in the region. Practically nothing is known concerning the character of these sediments within the quadrangle because

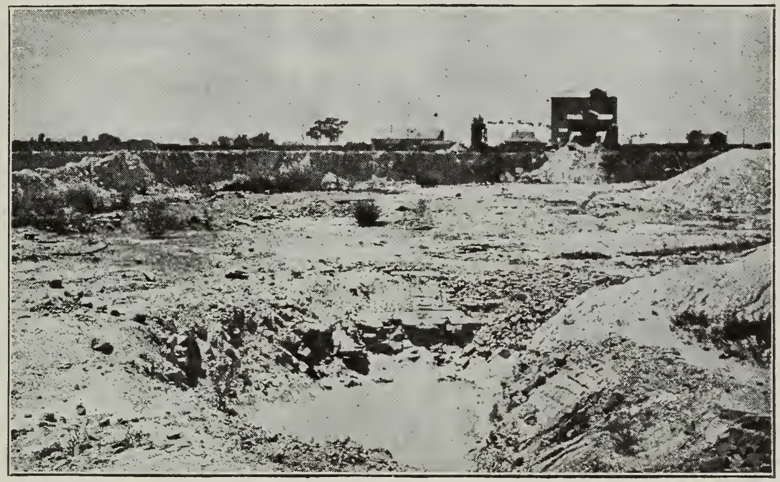


Fig. 17. Sink-hole in Niagaran dolomite at Lehigh Stone Company quarry. The shale which it contained is piled on the right. In the foreground the stripping has been removed.

there are no outcrops, available drill cuttings, or open mines. The unconformity at the base of the Waupecan sandstone in the Morris quadrangle may account for the absence there of the limestone and No. 7 coal of the Herscher quadrangle.

OUTLIERS

East of the area underlain by Pennsylvanian strata, deposits which are supposed to be Pennsylvanian sediments are exposed in sink-holes in the surface of the Silurian dolomite. (See fig. 17.) Seven or eight of these

41 Culver, Harold E., op. cit., pp. 142-145.
42 Idem.

sinks are now visible just north of the Lehigh Stone Company quarry where the overburden has been removed. They are 3 to 15 feet deep and are as much as 30 feet long. They are irregular to circular in outline, and usually lie along large joints. Their walls are smooth and polished and show evidence of wear. The sinks are filled with thin-bedded, arenaceous, Pennsylvanian shales, which are carbonaceous in part and even contain tiny seams of coal. The shale is black or blue in color, and where it is bedded the beds dip toward the center of the sink.

The sinks evidently developed during an erosion cycle previous to Pennsylvanian deposition in the area and were later filled by Pennsylvanian sediments. Evidence indicating two periods of deposition has been found in these sinks.[43]

At other localities in the Herscher quadrangle, as at the Bonfield quarry and in the outcrop of Edgewood strata a quarter of a mile west of Custer Park, small sinks or enlarged joints are filled with clean, even-grained, white to greenish sandstone which also may be Pennsylvanian.

Well records in various places show shale or sandstone containing thin coals above the Silurian strata. Such carboniferous shale or sandstone probably represents outliers of Pottsville or younger Pennsylvanian rock. The localities at which these wells occur are tentatively mapped as Pottsville.

Pleistocene System

The mantle of loose material which covers practically all of the Herscher quadrangle consists almost entirely of Pleistocene glacial deposits. Subsequent to deposition, some of these materials have been eroded or reworked by wind or water, and over most of the area the surficial portion has been altered by the various weathering processes.

Although five different drift sheets of Pleistocene age have been recognized in Mississippi Valley, including Illinois, only one—the Wisconsin—occurs in the Herscher quadrangle, some if not all of the others doubtless once existed in the quadrangle but they were buried, removed, or incorporated by the Wisconsin glacier.

WISCONSIN DRIFT SERIES

All of the Pleistocene deposits in the Herscher quadrangle belong to three subdivisions of the Wisconsin drift series. These three drift formations are the Marseilles drift, the Minooka-Rockdale drift and the Kankakee torrential deposits. Each formation is distributed over a distinct portion of the quadrangle. (See Plate I.)

43 Ekblaw, George E., Paleozoic karst topography: Trans. Illinois State Acad. Sci., vol. 17, pp. 208-212, 1924.

MARSEILLES DRIFT FORMATION

The Marseilles drift comprises the surficial deposits in the south part of the quadrangle and underlies Kankakee torrential deposits in an adjacent area in the west part of the quadrangle (Pl. I). The terminal moraine of the Marseilles drift extends across the south end of the quadrangle and grades northward into ground-moraine.

The thickness of the drift varies widely, due to the relief of the preglacial erosional surface (fig. 30) and to the irregular surface of the drift itself. Southwest of Buckingham the drift is more than 175 feet thick, but in few places in the southeast part of the quadrangle is it more than 100 feet thick. It decreases in thickness to the north until it is entirely absent.

The Marseilles drift in the Herscher quadrangle consists almost wholly of till, which is a nonassorted mixture of clay, silt, sand, gravel, and boulders,

Fig. 18. A kame on the Marseilles moraine, sec. 1, T. 29 N., R. 10 E. Gravel is taken from the pit on the left.

but it contains pockets and lenses of poorly assorted stratified clay, sand, and gravel, and there is at least one kame (fig. 18) of poorly sorted material. The till (fig. 19) is typically bluish-gray, granular, very compact and impervious to water, and hard and gritty when dry but plastic and sticky when wet. It stands in nearly vertical walls for many years. Most of the few boulders that are contained in the till or scattered over the drift are angular or slightly rounded limestone blocks, but a great many of them are well rounded igneous rocks. A count of the boulders more than 6 inches in diameter which were found along streams in the drift area gave 67.7 per cent limestone, 3.1 per cent sandstone and quartzite, and 29.2 per cent igneous varieties.

The one kame occurs mainly in the northeast corner of sec. 2, T. 29 N., R. 10 E., and is somewhat isolated from the crest of the terminal moraine, which occurs about a mile south of the kame. It is a prominent knoll and rises steeply from the surrounding drift (fig.18). It is composed of cross-bedded, assorted materials intermingled with pockets of poorly sorted boulders, gravel, sand, and rock flour. Some of the gravel at the bottom of the pit has been cemented into conglomerate by iron oxide that was deposited from ground-water.

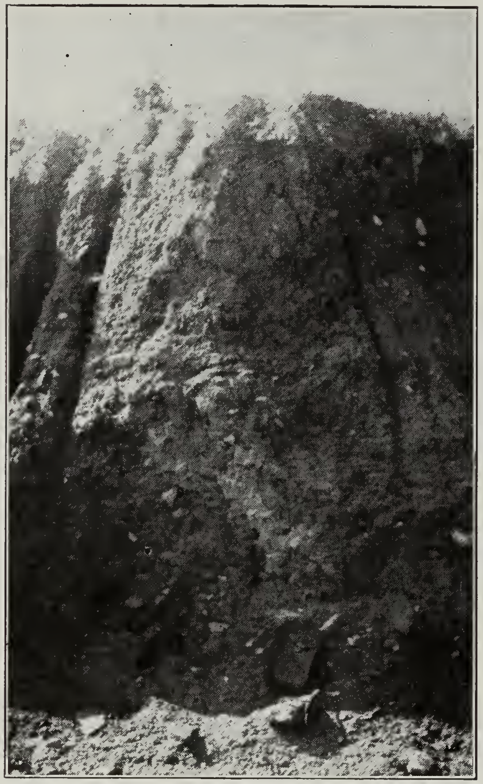


Fig. 19. Marseilles till in sec. 2, T. 31 N., R. 9 E.

The drift is covered by a few inches of loess-like material, probably wind-blown, which is not part of the till and which has weathered to a clayey soil. The upper 1½ to 4 feet of the till has been leached and weathered and is buff to brown in color and has lost the granular structure. The depth of leaching depends on the topography of the surface and the texture and composition of the till. The average depth of leaching on the ground-moraine is about 2½ feet.

MINOOKA-ROCKDALE DRIFT FORMATIONS

The drift that covers a small area in the northeast corner of the Herscher quadrangle may be either Minooka or Rockdale drift, or both. In view of this uncertainty it is referred to as the Minooka-Rockdale drift in this report. The drift consists of till which constitutes a terminal moraine, and of gravel which constitutes an outwash-plain lying in front of the moraine.

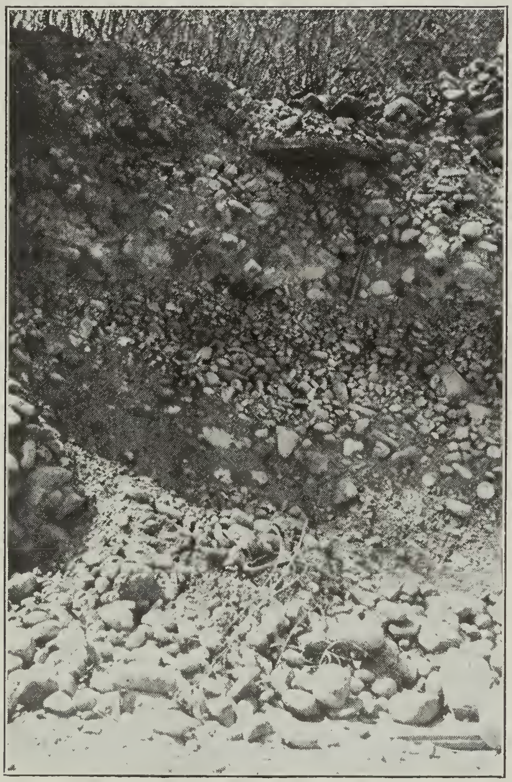


Fig. 20. Gravel deposit, possibly Rockdale or Minooka outwash, exposed in sec. 21, T. 32 N., R. 10 E. near Ritchie Station. The hammer marks a band of till. Note the irregular assortment and shape of pebbles.

The till in the moraine is like that in the Marseilles moraine, but it contains even fewer boulders. It has the same bluish-gray color and weathers to buff or light-brown. The greatest thickness of this till in the quadrangle is about 40 feet, as shown by well logs. The average depth of leaching is about 2½ feet.

The gravel that constitutes the outwash-plain is encountered in post-holes, cellars, et cetera, in the area in which it occurs. It is poorly exposed in the southwest part of sec. 24, T. 32 N., R. 10 E., just north of Binney School. In few places is it more than 5 feet thick, and it is covered by pebbly silt loam, which is either slope-wash from the moraine or fine fluvial deposits.

The stratified gravel that is exposed along a creek near the center of sec. 21, T. 32 N., R. 10 E., (fig. 20) may belong to the outwash gravel just described. The gravel is unassorted and contains silt, pebbles, cobbles, and boulders up to 2-foot slabs. All pebbles except those of chert are well rounded, the chert pebbles are angular, the cobbles are subrounded to subangular, and the larger fragments are hardly worn. About 90 per cent of the material is limestone and about 10 per cent is shale or siltstone; a few pebbles are of igneous material. Some till is contained in the gravel. The stratification is rude and dips northwest, showing that the waters from which the material was deposited flowed northwesterly. The deposit is on the leeward side of a rock ridge. The gravel is somewhat finer and more rounded than that in the more extensive deposits from Kankakee Torrent.

KANKAKEE TORRENTIAL DEPOSITS

Deposits from Kankakee Torrent[44] cover all of the surface of the Herscher quadrangle that lies below the 650-foot level (Pl. I). These deposits are best developed in a belt 8 to 10 miles wide along the south side of Kankakee River, where they consist of a discontinuous sheet of rubble covered by a few inches to 30 feet or more of sand. In most places the combined thickness of rubble and sand is between 6 and 15 feet, but in places both are absent.

In the east part of the quadrangle the rubble consists largely of angular to subangular blocks of local limestone (fig. 21). Most of these fragments are 3 to 6 inches in size, but many are 1 to 1½ feet in size. Sand fills the spaces between the limestone fragments. Farther west the rubble consists of smaller, more rounded fragments and contains more sand. Excellent exposures of the rubble occur along the concrete road in secs. 1, 2, 3, and 4, T. 30 N., R. 10 E., and in the dug ditch in sec. 2, T. 31 N., R. 10 E. Practically the whole area between Bonfield and Lehigh is covered by a sheet of rubble.

Long ridges, which are believed to have been bars in Kankakee Torrent, constitute a topographic feature in the area. The ridges are gently sinuous to nearly straight and may be as much as 3 miles long. Many of them are only 1 or 2 rods wide, but some are more than 15 rods wide, and they are usually less than 20 feet high, but both the width and height of any one ridge may vary. The slopes are commonly although not always gentle. One side

---

44 Ekblaw, G. E., and Athy, L. F., Glacial Kankakee Torrent in northeastern Illinois: Bull. Geol. Soc. America, vol. 36, pp. 417-428, 1925.

may be steeper than the other, and this relation may change on a single bar. The trend is commonly parallel to Kankakee River. The ridges are composed of rubble covered with sand or of sand alone. Some of the rubble bars show rude stratification. Generally the bars occur on the leeward side of elevated areas of bedrock, but some of them occur in the bottoms as well as along the slopes of present valleys. The crests of some of the bars are as much as 50 feet above the top of the bluffs along Kankakee River. Excellent

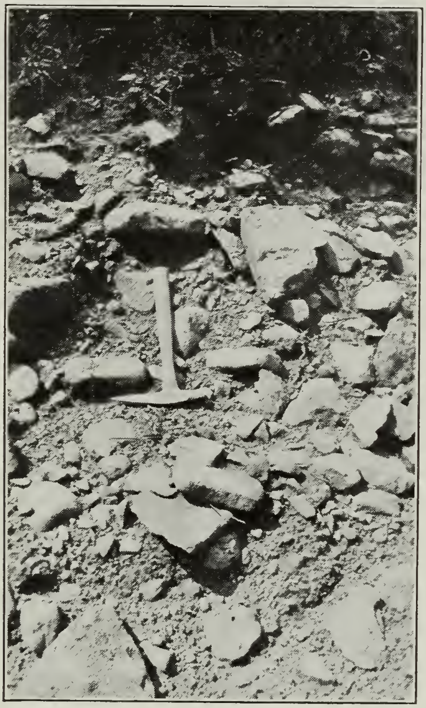


Fig. 21. Kankakee torrential deposits exposed along the southern edge of sec. 35, T. 31 N., R. 10 E. Note the angular blocks and lack of assortment.

examples of the bars occur in the south part of sec. 24 (fig. 22) and in sec. 9, T. 31 N., R. 10 E. The latter bar extends across the whole section. Several bars occur in secs. 3 and 10, T. 31 N., R. 9 E.

The rubble in the belt of prominent torrential deposits apparently grades laterally through fine gravel into noncalcareous, grayish-yellow, pebbly silt that covers Marseilles drift over a considerable area in the west part of the quadrangle. The pebbles in the silt are usually smaller than peas and constitute perhaps less than 2 per cent of the material. The silt is usually only 1 or 2 feet thick. Exposures of the intermediate type of material (fig. 23) occur in secs. 32 and 33, T. 31 N., R. 10 E., and in secs. 3, 4, and 5, T. 30 N., R. 10 E. As this silt occurs only beyond the areas covered by coarser

Fig. 22. Trees in the left part of the photograph are growing on the crest of a torrential bar composed entirely of sand, sec. 24, T. 31 N., R. 10 E.

Fig. 23. Torrential gravels intermediate in coarseness between the pebbly silt and the rubble. Sec. 33, T. 31 N., R. 10 E.

materials and in the wide parts of the Kankakee basin, it was probably deposited in the relatively quiet waters that bordered the direct line of flow of Kankakee Torrent.

Boulders, some of which are 5 or 6 feet in diameter, occur in great profusion in parts of the sand and rubble belt and are particularly conspicuous in the area just south of it. In one place it was estimated that there were 200 boulders per acre. They were probably carried into the area by the torrent or in ice-cakes floating in the torrent or they may be residual.

TORRENTIAL EROSION

Not only were considerable deposits made by Kankakee Torrent, but erosional features were also developed by it. Throughout most of the Kankakee and part of the Herscher quadrangles the steep slopes of the southern margin of the Minooka-Rockdale moraine and the northern margin of the Marseilles moraine indicate that they have been somewhat cut away and straightened. These decidedly steep slopes are continuous from top to bottom and their outlines in ground plan are smooth and sinuous. A glance at the topographic maps of the Herscher and Kankakee quadrangles will show the basin formed between the two moraines.

The region on both sides of Kankakee River is the site of numerous wide channels such as are now occupied by Terry and Ryan's creeks. (See fig. 2, p. 12.) They usually have steep walls, and their floors in many places are more than a quarter of a mile in width. Some are cut in bedrock, others in till or rubble. None of them appear to have been formed by the small streams which now drain them. They also extend in the same general direction as Kankakee River. On the floors of these channels are found poorly assorted rubble and sand, covered in places by recent swamp deposits. The highest of the channels probably represent "cut offs" and overflow channels formed during the highest stage of the torrent. Those at lower levels represent the various channels selected by the torrent during its declining stages when the irregularities of the rock floor caused the waters to select devious routes, thus forming a braided pattern. They were formed at a time when the water level was low in the Morris Basin.

Over large areas below the 650-foot level the bedrock has been swept clean of its mantle of till and covered by a little sand or rubble. The surface of the limestone rock has weathered relatively little and presents an almost smooth but slightly undulatory surface. There is no evidence of glacial action, such as a polished surface or parallel striae or grooves on the bedrock. It is just such a surface as one would expect to find developed under the scouring action of a vigorous torrent of water. The greatest accumulations of coarse rubble are found immediately downstream from such high areas of scoured rock. The bedrock has been scoured over an area several square miles in extent in the vicinity of Lehigh, and great quantities of rubble occur just to the northwest of it.

As has already been mentioned, the rubble, sand, and silt, the bars, the great number of boulders, the abandoned channels, and the water-worn bedrock surfaces all occur at or below the 650-foot level in the Herscher area. Above that level the topography is gently rolling and typically morainic; below that level, with the exception of the dunes, bars, and abandoned channels, the surface on both the Minooka-Rockdale and Marseilles moraines is nearly flat. This change in topography can be traced almost around the entire basin. In the western part of the Morris basin it occurs at 640 feet, in the eastern part of the Herscher quadrangle just below 650 feet, and farther east in the Kankakee quadrangle almost at 660 feet. The exceedingly flat-topped Minooka Ridge north of Illinois River is below the 640-foot level. Where Illinois River cuts through the Marseilles moraine at the western end of the Morris basin there is a rather definite shoulder just above the 640-foot contour. It is not known whether this topographic feature occurs along Illinois River below Marseilles.

Fig. 24. Front of a large, stationary dune, half a mile north and three quarters of a mile east of Essex.

Recent Deposits

DUNE SAND

Recent deposits in the area are primarily eolian. They cover the same general area as the torrential deposits previously described and consist of dunes which have been built of the sand carried into the area by Kankakee Torrent. Very little if any of the sand has been carried into the region by the wind. Commonly the torrential bars have become covered with sand and appear as large stationary dunes.

A large ridge extending northwest from Essex is a great compound dune probably built on a large bar. Another area of large dunes occurs in secs. 7 and 8, T. 31 N., R. 10 E. Some of these dunes are over 20 feet high. Most of them are stationary and covered with vegetation. (See fig. 24.) In some places, especially where cultivation has been attempted, the sand has shifted

Fig. 25. A migrating dune in sec. 8, T. 31 N., R. 10 E.

Fig. 26. A "blowout" in a dune in sec. 33, T. 32 N., R. 9 E.

considerably (figs. 25 and 26). "Blowouts" are numerous on some of the larger dunes. Locally, shifting sand makes the roads nearly impassable, and fences are often quickly covered.

The sand in the dunes is fine, angular to well rounded, and rather even-textured. (See mechanical analysis, Table 7.) The surface sand is very clean and contains little clay or organic matter. Certain bands in the lower part of some of the dunes have been more or less cemented by iron oxide. No satisfactory explanation of the process by which this cementation has taken place is known, although the iron oxide was undoubtedly precipitated from ground water.

The areas of sand at lower levels between the dunes and bars contain a considerable number of boulders, cobbles, and chert pebbles which represent the concentration after the fine sand has been blown away and built into dunes. A few cobbles and pieces of chert are found on the dunes, but these were undoubtedly carried there by Indians. This explanation seems especially logical as these dunes are surrounded by swamps and probably provided the best trails across the low areas before the country was occupied by white men.

TABLE 7—*Mechanical analyses of dune sand from the torrential deposits (in per cent of the total sample by weight)*

Location of Sample	Coarse sand 1-.5 mm.	Medium sand .5-.25 mm.	Fine sand .25-.1 mm	Silt .1-.01 mm.	Mud .01 mm.
⅓ mile west of Ritchey	2.0	38.8	55.3	1.0	2.9
1 mile south of Braidwood	.1	8.9	84.5	3.2	3.3

Minerals found in the two samples of dune sand are commonly quartz, orthoclase, garnet, hornblende, and apatite; less commonly magnetite, epidote, hypersthene; and rarely andalusite. The minerals show no indication of chemical weathering in spite of the fact that they have been exposed since Pleistocene time or longer. The grains vary in shape from well rounded to sharply angular. Nearly all of the quartz and orthoclase grains were well rounded, but most of the apatite, garnet, and andalusite showed little evidence of wear. The analysis of these detrital sands presents a marked contrast to the analysis of the residual minerals from the indurated strata.

ALLUVIUM

Alluvium is present in some of the larger valleys. In some places Kankakee River has a very narrow flood-plain, but in most places in the Herscher quadrangle it has no flood-plain. The flood-plains of Kankakee River and Horse Creek are covered with alluvium. Both of these streams have higher terraces which were formed during the close of the Pleistocene period and which are seldom, if ever, flooded.

BOG MATERIALS

Bog materials have accumulated and are accumulating in many of the swamps of the area. These swamps are usually located between dunes or bars and are commonly small, but some attain a considerable size. Much of the area north of Essex is low and is usually covered with water a few inches deep. A single swamp in secs. 5, 8, and 9, T. 31 N., R. 10 E., covers over half a square mile. The depth of the bogs and of their vegetable accumulation is not known, but most of them are rather shallow.

CHAPTER III—STRUCTURAL GEOLOGY

Introductory Statement

Structural geology is the phase of geologic science concerned with the determination, representation, and interpretation of rock structure which results from earth movements.

Rock structures may be determined in one of several ways by the field geologist. In regions of considerable folding, measurements of the amount and direction of maximum dip or slope of the rocks may be made at numerous points, and the structure determined from those data. If the rock beds have been disturbed only slightly, the structure is determined best by using surveying methods to obtain the location and elevation of outcrops of rock beds of known stratigraphic position. With these data, supplemented by observations of local dips, it is usually possible to determine the structural features with considerable accuracy. In many regions, such as the greater part of Illinois, however, outcrops are few, and the geologist must supplement data from them by use of records of wells and shafts. As the depth of any bed recognizable in well records subtracted from the elevation of the ground gives the elevation of the bed at that point, it is a relatively simple matter to make use of this type of data if the records are accurate, and distinctive beds are penetrated by the wells.

The geologic structure may be represented on maps by symbols showing the direction and amount of dip, or by contours showing the elevation of the key-bed or key-beds used (figs. 27 and 28).

The interpretation of structure maps is important, both in determining the nature and time relations of geologic processes active in the past, and in providing information for the development of mineral resources. From such maps it is possible to determine the depth to water-bearing beds, the probable location and extent of coal beds, localities favorable for testing for oil and gas, and data on other mineral resources which may be present.

In the Herscher area the rocks are in general nearly flat-lying. The scarcity of outcrops and well data and the absence of good horizon markers at shallow depths make detailed determination of structure over most of the quadrangle impossible. Locally, however, data available on the elevation of various strata permit an interpretation of the structure of portions of the quadrangle.

Structure of St. Peter Sandstone

Only two wells within the area penetrate the St. Peter sandstone. At Custer Park the elevation of the top of the St. Peter sandstone is 66 feet

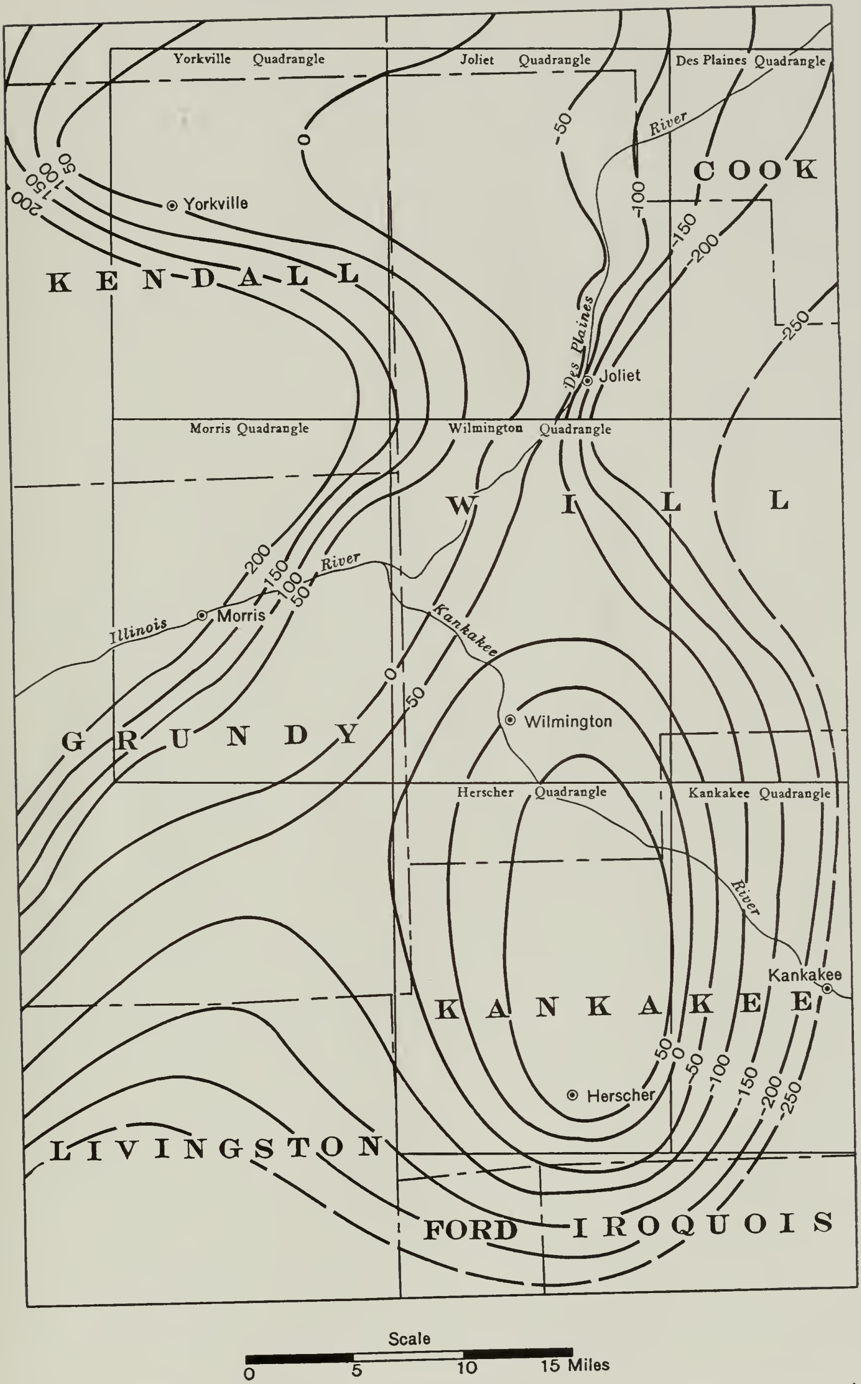


Fig. 27. Structure contours showing the elevation of the St. Peter sandstone in part of northeastern Illinois; contour interval, 50 feet. Drawn by D. J. Fisher.

above sea-level, at Herscher it is 70 feet above sea-level, at Braidwood, north of the quadrangle, it is 64 feet below sea-level, at Coal City it is 46 feet below sea-level, and at the Wadleigh well, south of the quadrangle, it is about 25 feet below sea-level.

Data on the elevation of the St. Peter sandstone at these points and at others farther from the Herscher quadrangle have been used to determine structural conditions in a considerable area in northeastern Illinois. The structure contour map, figure 27, is based on data given in the reports on the Morris,[1] Joliet,[2] and Wilmington[3] quadrangles, and on the LaSalle anticline.[4] The map shows an area of high elevation of the St. Peter sandstone which is referred to in the Wilmington report as the Ritchey-Herscher arch. This fold is broad and flat but is considerably elongated in a north-south direction.

Data on Other Formations

The Platteville-Galena formations are apparently parallel in structure to the St. Peter formation, but at present no data are available on which structural contours may be based in addition to those for the St. Peter sandstone.

The top of the Richmond formation is not a suitable surface for the determination of structure due to the relief developed during pre-Silurian erosion. Well records show that the surface of this formation is marked by a broad elevated area in the vicinity of Herscher. From a general north-south line across the center of the quadrangle the surface of the shale slopes both eastward and westward, a feature which may be either structural or erosional.

The Silurian strata have a general eastward dip of approximately 30 feet per mile in the eastern part of the quadrangle. In the vicinity of Lehigh, in sec. 7, T. 30 N., R. 14 W., the strata are very nearly horizontal. Local variations in directions and amount of dip occur, but no local dip of more than 2° was observed. The strata are cut by a system of vertical parallel joints which strike N. 75° W. There are also minor joints trending N. 30° to 40° E. The sinks described on pages 61-62 commonly occur on the crest of minor folds and may have developed in open joints caused by the warping.

1 Culver, H E., Geology and mineral resources of the Morris quadrangle: Illinois State Geol. Survey Bull. 43-B, 1923.

2 Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, 1925.

3 Fisher, D. J., Geology and mineral resources of the Wilmington quadrangle: Illinois State Geol. Survey (unpublished manuscript).

4 Cady, G. H., The structure and history of the LaSalle anticline: Illinois State Geol. Survey Bull. 36, 1920.

Structure of Kankakee Dolomite

Along Kankakee River the structure of the Silurian beds is clearly shown (fig. 28). The elevation of the Niagaran-Kankakee contact is 565 feet above sea-level at Wesley in sec. 19, T. 32 N., R. 10 E. This locality possibly marks the base of a very minor syncline striking in a northeasterly direction, as is indicated by data in the Wilmington quadrangle.[5] This contact rises in elevation to 587 feet in the north bank of the river in the eastern part of sec. 27 and slightly over 590 feet in sec. 26 of the same township. Still farther east the elevation decreases to 585 feet in the eastern part of sec. 35, 578 feet in the center of sec. 36, and approximately 560 feet at the Kankakee-Will

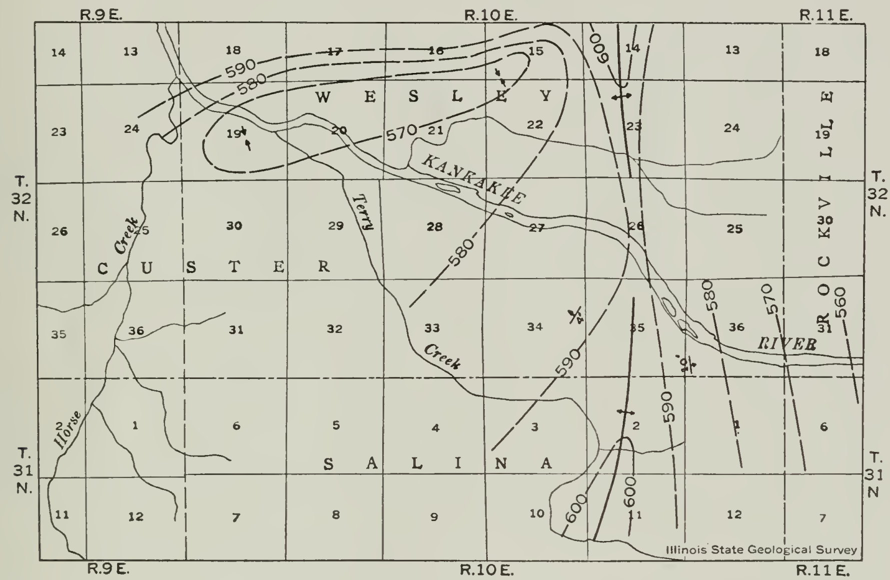


Fig. 28. Structure contours showing the elevation of Kankakee dolomite in the vicinity of Kankakee River, based on data in this report and the unpublished report on the "Geology and Mineral resources of the Wilmington quadrangle" by D. J. Fisher.

county line. In the western part of sec. 2, T. 31 N., R. 10 E., this contact is at 600 feet above sea-level. Obviously a small anticlinal fold exists in the Silurian strata. Its axis is roughly perpendicular to Kankakee River and its crest is in the western parts of secs. 26, 35, and 2. The easterly dip is about 10 feet and the westerly or northwesterly dip is some 4 feet to the mile. Only meager evidence from well records indicates that this gentle fold continues southward across the central part of the quadrangle.

5 Fisher, D. J., Geology and mineral resources of the Wilmington quadrangle: Illinois State Geol. Survey (unpublished manuscript).

Structure of Pennsylvanian Strata

The structure of the Pennsylvanian strata is known over much of the area because of the considerable number of holes drilled in testing for coal. There is a distinct angular unconformity between these beds and those of the earlier Paleozoic systems. The underlying Ordovician and Silurian sedimentary rocks dip to the eastward whereas the Pennsylvanian strata dip to the west and southwest.

The red contours on Plate I are based on data from the records of the coal-test borings and show the structure of the No. 2 coal in the western part of the quadrangle. In general the coal has an average dip of about 30 feet per mile to the west, but the dip is by no means constant. The dip of the coal is somewhat steeper near the outcrop along the eastern part of the area contoured than it is farther out in the basin. This difference in slope may be due, at least partially, to difference in slope of the surface on which the coal was deposited, for the underlying limestone surface rises near the outcrop of the coal, suggesting that it was a topographic elevation during the Pennsylvanian period. Small irregularities in structure are common in the coal in northeastern Illinois. Differences of 50 feet in the elevation of the coal within less than a mile have been encountered near Coal City.[6] Irregularities in the amount and direction of dip similar to that a mile east of Reddick (see contours on Pl. I) are common in the region.

The structure of the coal west and southwest of Buckingham is not known in detail, but there is evidence that the strata have the same general dip to the west which is characteristic farther north in the area of numerous coal borings. The continuation of this dip brings the coal down to an elevation of 400 feet above sea-level at Cardiff, about 6 miles west of Buckingham.

---

6 Cady, G. H., Coal resources of District I: Illinois Coal Mining Investigations Bull. 10. p. 51, 1915.

CHAPTER IV—GEOLOGICAL HISTORY

Paleozoic Era

The geological history of Illinois during the Paleozoic Era is read, by geologists, partly from the outcrops of the rock formations and partly from records of deep borings. The knowledge gained may be supplemented by a knowledge of events which transpired in adjacent regions. Similarly a knowledge of the geological history of the Herscher quadrangle, as determined from the local bedrock formations which are exposed or penetrated by borings, may be supplemented and made more complete by drawing up the facts gleaned from studies of adjacent areas. This is true because, generally speaking, processes which were operative in the Herscher quadrangle were operative over considerable areas outside. Hence, we can interpret the history of the earlier periods with a certain degree of confidence, even though rocks of those ages are not readily accessible within the quadrangle.

During all of the ages, the continents have been sources of sediments for deposition in the oceans. Gravels, sands, silts, clays, and mineral matter in solution have, at various times and places, been transported, worked over and assorted, and deposited beneath the seas, the coarser being generally deposited near shore, the finer farther out. After consolidation by compacting and cementation the beds of gravel become beds of conglomerate, sand becomes sandstone, silt and clay become shale, and chemical precipitates and organic secretions of lime carbonate become limestone.

Record of the motions of water may be preserved by cross-bedding, ripple and rill marks, cutting out of portions of beds, et cetera. Shallow water conditions may be recorded by sun-cracks, rain-drop impressions, worm borings, and the foregoing evidences of water currents. Widespread limestone formations indicate that the adjacent continents were low or distant, coarse clastic sediments indicate that the continents were high or near.

Earth movements leave their record in warped or folded or faulted strata. Erosion between two epochs of marine deposition is recorded by irregular contacts between the formations deposited during those epochs, by evidences of weathering in the upper part of the older formation, by the occurrence of residual detritus in the base of the younger formation, or by the occurrence in the younger formation of fossils or organisms more advanced in their evolution than those in the older formation. Changes in the life forms, as revealed by their fossil remains, are made a matter of earth record, and by studying the fossil content of successively younger formations, the history of life development is traced.

Little is known regarding the pre-Paleozoic history of Illinois because the rocks of this early time are completely buried and have not been penetrated by the drill or artificial excavations of any kind. Judging from the known history of this time elsewhere, erosion was so prolonged before the incursion of the Cambrian sea that the land area had been reduced to fairly low relief. This erosion probably continued in Illinois through Early and Middle Cambrian times, until the invasion of the sea in the Late Cambrian epoch.

CAMBRIAN PERIOD

LATE CAMBRIAN EPOCH

The submergence of the Middle West region by the Late Cambrian sea changed Illinois from a land area to an ocean bed. Sediments of sand, mud, and lime carbonate from the Canadian area were deposited by the ordinary processes in operation in the oceans today, and the sea remained continuously for so long a time that there were deposited the sediments of the Mt. Simon sandstone (basal), the Eau Claire sandstone and shale, the Dresbach sandstone, the Franconia dolomite, sandstone, and shale, the Mazomanie sandstone, the Trempealeau sandy dolomite and dolomitic shale, and the Jordan sandstone. The well at Dixon, Illinois, which has gone deepest into this series, shows a total thickness of Cambrian strata of at least 1480 feet, without reaching the base of the Mt. Simon sandstone.[1]

ORDOVICIAN PERIOD

PRAIRIE DU CHIEN EPOCH

There were no great relative changes between land and water at the close of the Cambrian Period in this part of the continent, and as a result Ordovician sediments were laid down conformably upon the Cambrian. During Early Ordovician time the ocean encroached farther upon the land, thereby reducing the area exposed to erosion and shifting the shore-line farther and farther north. In northern Illinois the Oneota sea was clear, and lime-sediment was the chief material deposited. During New Richmond times conditions changed, permitting the deposition of sands. This change in sedimentation probably records considerable oscillation of the shore-line and some rejuvenation of the streams which were draining the land area to the north. During Shakopee time clear water conditions, with local interruptions, again prevailed and lime-mud deposition was resumed.

---

1 Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois State Geol. Survey Bull. 49, p. 38, 1926.

Thwaites, F. T., Stratigraphy and geologic structure of northern Illinois: Illinois State Geol. Survey Report of Investigations No. 13, pp. 34 and 35, 1927.

At the close of the Shakopee epoch the sea withdrew, and at least the northern part of this State became land, subject to erosion. The magnitude and extent of erosion was sufficiently great to make the suggestion plausible that the boundary between the Cambrian and Ordovician formations should be drawn at the uneven top of the Shakopee limestone.

MID-ORDOVICIAN EPOCH

Upon the eroded surface just described the St. Peter sandstone was deposited. Although there is some difference of opinion among geologists concerning the origin of this formation, it appears that most of it was deposited under marine conditions.

Following St. Peter time there ensued a period of erosion when an unknown amount of St. Peter sandstone was removed, and this was followed by deposition of the Platteville, Decorah, and Galena formations without appreciable interruption. Conditions were suitable for the growth of animals that secreted calcareous shells, resulting in the deposition of limestones of considerable thickness. Locally there was deposition of mud to form the Decorah shale during the transition from Platteville to Galena times. After the deposition of several hundred feet of Galena sediments, the sea again withdrew until Richmond time.

LATE ORDOVICIAN EPOCH

RICHMOND TIME

During the Waynesville stage of Richmond time, the sea transgressed the Herscher quadrangle from the south[2] and there was deposited the shaly beds of Richmond age. The same sea extended into Missouri and Tennessee.

SILURIAN PERIOD

ALEXANDRIAN EPOCH

As shown by the very uneven nature of the upper surface of the Richmond series, a considerable period of erosion followed the deposition of the Richmond sediments and lasted until the incursion of a southern sea in early Alexandrian time. Marked similarity between the fossils of the Edgewood formation in northeastern Illinois and those in southern Illinois and Missouri, and considerable similarity between these and the "Clinton" (Lower Silurian) fossils of Ohio and Indiana indicate that the three regions were submerged by the same southern sea. The Illinois-Indiana embayment, however, was separated from the Ohio embayment by the Cincinnati Arch.

---

[2] Savage, T. E., Richmond rocks of Iowa and Illinois: Am. Jour. Sci., 5th ser., vol. 8, pp. 411-427, 1924.

During Edgewood time the sea advanced from southern Illinois northward over the Herscher quadrangle. During the deposition of the oolitic beds the quadrangle was occupied by local stretches of quiet water such as might be expected along the irregular coast of a shallow sea. A little later the sea appears to have withdrawn slightly so that deposition was discontinued in the parts of the area where the oolite beds are found and continued in other parts, where it is now represented by the Essex limestone.

Much the same conditions continued into the Kankakee epoch. The water in the Herscher area gradually deepened and a northern arm of the sea appears to have developed connecting the Illinois embayment with an embayment in the Anticosti region, as faunal elements found in the Kankakee formation of northeastern Illinois and Wisconsin occur in the Anticosti section but not in the Sexton Creek formation in southern Illinois and Missouri and the "Clinton" formation in Indiana and Ohio.[3]

NIAGARAN EPOCH

Conditions favorable for the formation of limestone continued in the Herscher area throughout the Niagaran epoch also, as there is no definite break between the Niagaran series and the Kankakee formation. The Niagaran fauna in the Herscher area is similar to Niagaran faunas to the north, indicating that the central interior sea was connected with northern oceans during this epoch.

As the transporting power of moving water is measured by the size of the sediment it carries, the maximum size of the residual grains in any marine sediment may indicate the relative distance from shore at which the particular sediment was deposited. Consequently the coarse and medium sand in the Edgewood formation indicates that the shore of the Edgewood sea must have been near the Herscher quadrangle—an opinion also suggested by the oolite itself; the coarse and medium sand in the Kankakee formation indicates the same relation existed during the Kankakee epoch, but the larger proportion of mud suggests that the shore-line was somewhat farther away and deeper water prevailed in the Herscher quadrangle. The small amount of clastic material, the lack of coarse and medium sand, and the large proportion of mud and silt in the clastic material in the Niagaran dolomite indicates that the shore of the Niagaran sea was far from the Herscher quadrangle. (See fig. 29.) Furthermore, as sediments derived from nearly adjacent igneous rocks contain slightly resistant as well as more resistant minerals, the presence of only very resistant minerals in all the Silurian strata in the Herscher quadrangle indicates that the minerals had been subjected to sev-

3 Savage, T. E., Alexandrian rocks of northeastern Illinois and eastern Wisconsin: Bull. Geol. Soc. America, vol. 27, p. 314, 1916.

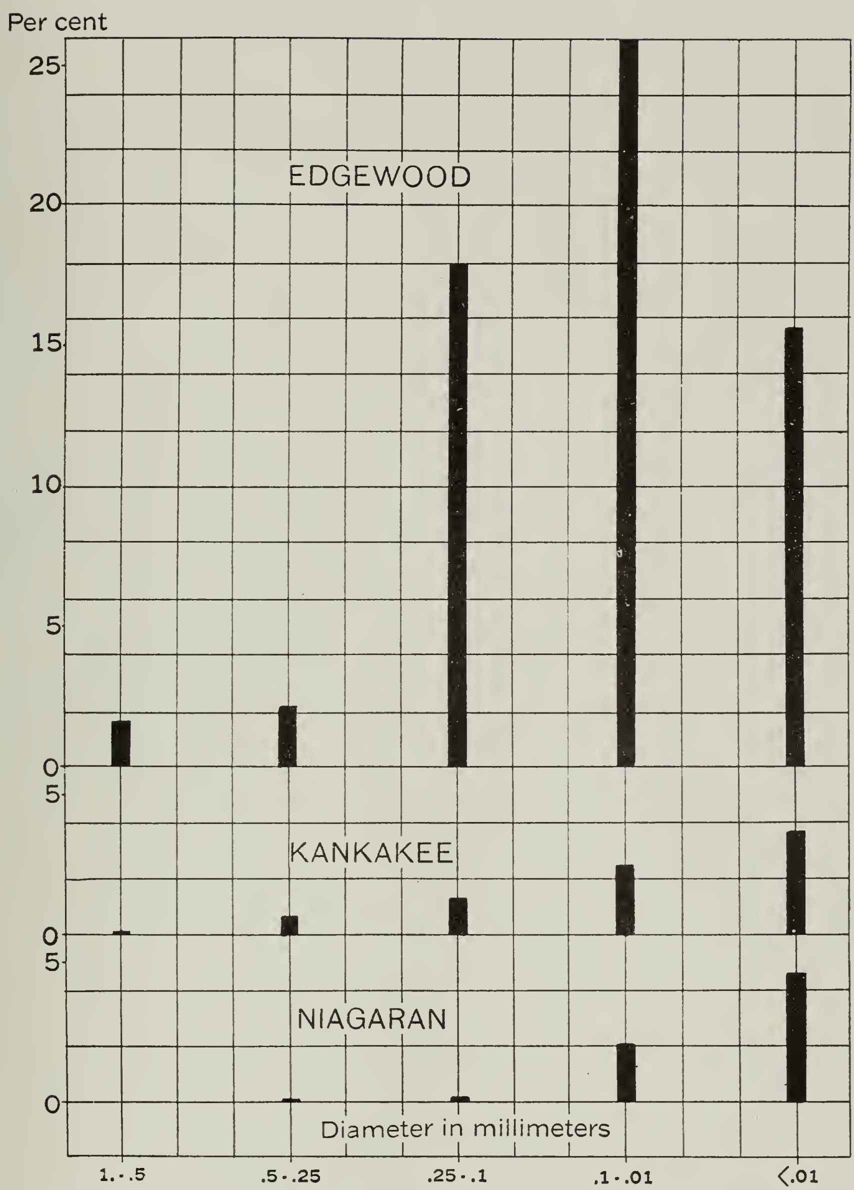


Fig. 29. Graphs of the averages of the mechanical analyses of Edgewood, Kankakee, and Niagaran sediments. Note that some coarse sand (1-.5 millimeter) occurs in the Kankakee but not in the Niagaran sediments.

eral cycles of abrasion and that consequently the streams that contributed the clastic constituents flowed over sedimentary rocks.[4]

POST-NIAGARAN PRE-PENNSYLVANIAN INTERVAL

As formations younger than the Niagaran and older than the Pennsylvanian are now absent from the Herscher quadrangle, it is known only that if such formations were deposited in the area they were removed by erosion before the Pennsylvanian sediments were laid down. The occurrence of late Devonian or early Mississippian sediments in fissures in Niagaran dolomite in northeastern Illinois[5] indicates that at least once in the interval between Niagaran and Pennsylvanian times the sea covered this part of the State. During a part of this interval also the Niagaran dolomite was subjected in some places to a great deal of solution from surface waters, producing a Karst topography and later, probably in Pennsylvanian times, sinks thus formed were filled with sediments.

No extensive deformation is known to have taken place in the area before the deposition of the Silurian sediments. Although gentle warpings like those in the Shakopee and St. Peter strata in LaSalle County[6] probably affected the Herscher area at the time of that deformation, the angular unconformity between Pennsylvanian and earlier Paleozoic strata indicates that the greatest movement in the Herscher quadrangle occurred after the Silurian period and before the Pennsylvanian. This deformation probably occurred after Devonian and possibly in Late Mississippian time.[7]

PENNSYLVANIAN PERIOD

POTTSVILLE EPOCH

During the Pottsville epoch the ocean advanced from the south through Illinois, reaching the Herscher quadrangle towards the end of the epoch. Shallow-water conditions with ephemeral marshes prevailed as indicated by the shales, sandstones and thin coals.

CARBONDALE AND MC LEANSBORO EPOCHS

The Carbondale epoch opened with a widespread forest swamp that lay quite or nearly at sea-level and extended over much of the eastern Interior Basin. The peat which accumulated in this swamp was subsequently converted into No. 2 coal. After the peat bed had formed but before it had become coal, the swamp was flooded with sea-water and layers of fine mud

---

[4] Holmes, Arthur, Petrographic methods and calculation, pp. 160-204. London, 1921.

[5] Weller, Stuart, A peculiar Devonian deposit in northeastern Illinois: Jour. Geol. vol. 7, pp. 483-488, 1899.

[6] Cady, G. H., The structure of the LaSalle anticline: Illinois State Geol. Survey Bull. 36, p. 175, 1920.

[7] Cady, G. H., op. cit.

were deposited on top of the peat, starting the formation of the fine-grained roof-shale.

During the remainder of the Carbondale epoch a succession of lenticular sandstones, shales, and coal beds was laid down, this varying succession recording a corresponding fluctuation of conditions. How much of these strata were laid down in a marine environment, and how much in a continental environment cannot be told from the present stratigraphic record observable. It is believed, however, that a long time transpired between the deposition of the peat beds which later changed into No. 2 coal and No. 7 coal respectively, and furthermore that only a small part of this interval was consumed by the deposition of sediments. Submergence and the deposition of the limestone which marks the base of the McLeansboro formation probably followed an interval of emergence and erosion.

CLOSE OF THE PALEOZOIC ERA

The last period of the Paleozoic era, known as the Permian Period, is not represented by deposits in Illinois except near Danville, some seventy miles south of the Herscher quadrangle. Deposition may have been general, but if so the sediments have since been removed. On the other hand, erosion may have been the prevalent process.

The deformative movements which were responsible for the notable folding of the Appalachian Mountains at the close of the Permian, the last period of the Paleozoic Era, also renewed the LaSalle anticline in Illinois and to a minor extent warped the strata in the Herscher quadrangle, moderately tilting them toward the east. So far as known the Herscher quadrangle has since been subjected to erosional processes.

Mesozoic Era

During the entire Mesozoic Era, the Herscher quadrangle was a land area, subjected to the incessant attack of erosional agencies. Although the Mesozoic Era was probably not so long as the Paleozoic Era, it was nevertheless a long one, and there may have been removal of considerable thickness of Pennsylvanian and older sediments, but this would depend upon the original height of the area, or periodic uplift. The various erosional levels or peneplains of the Appalachian region cannot be detected in the Herscher quadrangle, possibly because the rock surface is mostly concealed by glacial drift.

Cenozoic Era

TERTIARY SUB-ERA

The Gulf Embayment of early Tertiary times reached only the southern tip of Illinois so far as known. The Herscher quadrangle remained a part of the land area, subject to erosion. It appears that just before Pleistocene times there was uplift and the beginning of a new cycle of erosion, as indicated by a deeply buried valley under the glacial drift in the southwest corner of the quadrangle, and by the rock-walled channels of Terry and Ryans creeks, extending below a fairly uniform summit level. (See fig. 30.)

PLEISTOCENE PERIOD

Five continental glaciers, named in order of age Nebraskan, Kansan, Illinoian, Iowan, and Wisconsin invaded the Mississippi Valley states during the Pleistocene period, but only the Illinoian and Wisconsin are positively known to have transgressed the Herscher area. Wisconsin drift covers the quadrangle, and although no Illinoian till has been found in the quadrangle its distribution in the State implies that the glacier surely extended over the quadrangle.

WISCONSIN EPOCH

The Wisconsin glacier that invaded Illinois advanced from the northeast, the center of accumulation lying in the Labradorean peninsula in Canada. The glacier developed a lobate margin as it advanced over the Great Lakes, because the basins of the lakes and their larger embayments permitted a more rapid advance than occurred outside such basins. Similarly large valleys or lowlands caused lobes of a minor order. Each lobe is designated by the name of the lake, bay, or valley that caused its development.

The front of the glacier advanced when accumulation exceeded melting, it remained stationary when accumulation balanced melting, and it retreated when melting exceeded accumulation. Major oscillations of the ice-front are know to have occurred during the general retreat of the glacier, as indicated by the recessional moraines, and possibly occurred also during its advance. Minor oscillations also occurred at all times.

Like all glaciers, the Wisconsin glacier incorporated within itself some of the material over which it moved, and deposited the material as drift when it melted. This explains why boulders and smaller fragments of rocks that are known to occur originally only in Canada are found in the Herscher area. Pronounced ridges of drift, or moraines, accumulated at the margin of the glacier whenever it remained stationary for any length of time. These ridges usually consist of till, or unassorted drift, but in some places the streams upon, within, or under the glacier discharged a considerable amount of rudely assorted material at one place, producing a high knoll of gravel, called a kame. In other instances streams at the base or within the glacier deposited assorted material along their courses, and such material now exists as a ridge of gravel that is called an esker. The water that was derived by the melting of the glacier usually flowed directly away from the front of the glacier. If it carried much material the material might be deposited as

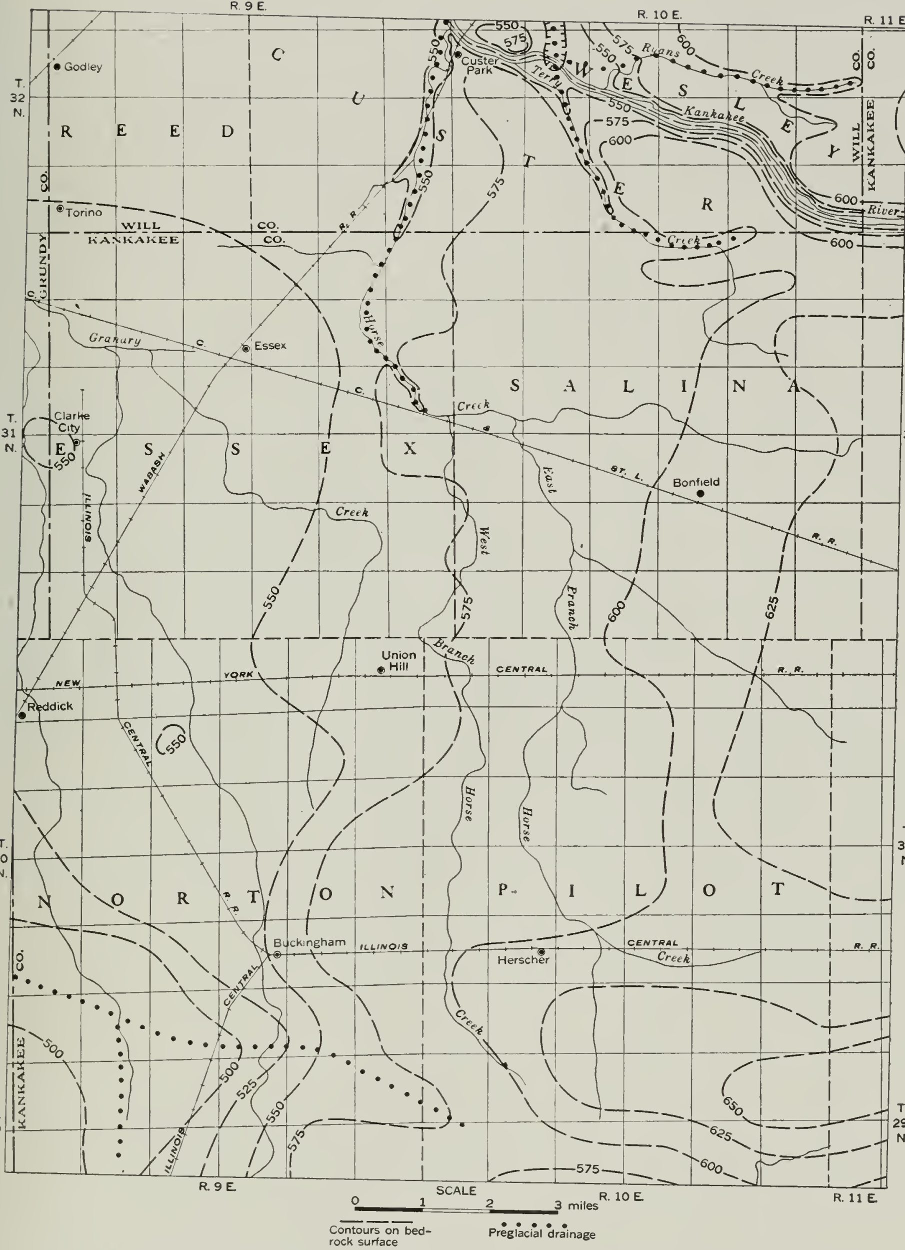


Fig. 30. Map of the Herscher quadrangle showing bedrock topography and preglacial drainage.

a sheet of gravel or outwash-plain in front of the moraine, or as fills or valley-trains in the valleys down which the water escaped. Drift was also deposited as ground-moraines beneath a glacier, and this drift was increased as the glacier receded.

The Wisconsin glacier did not make a single advance and retreat, but its retraction from its maximum advance was interrupted by several major readvances, which are designated as stages. How far the glacier receded at the end of each recessional stage cannot be determined, but the distance was sufficiently far that the marginal outline of the glacier at each readvance was different from the preceding one. The position of the margin at the maximum advance and at each subsequent readvance is marked by a moraine. The moraines of Wisconsin drift have each been named, usually from a town which is now located upon the moraine, and the same names are applied to the respective stages. In order of age, the Wisconsin moraines in Illinois are named Shelbyville, Cerro Gordo, Champaign, Belvidere, Bloomington, Marengo, Marseilles, Minooka, Rockdale, Valparaiso, and Lake Border. Some of these are subdivided and the subdivisions also named.

The Wisconsin glacier moved over the Herscher area during all of the stages preceding and including the Marseilles. Together with whatever glaciers preceded it, it abraded, scoured, and polished the bedrock to a smooth, gently undulatory surface and filled the preglacial valleys with glacial drift. Whatever drift may have been deposited previous to the Marseilles stage was buried by or incorporated in the Marseilles drift.

Marseilles stage. The front of the Wisconsin glacier during the Marseilles stage stood across the south end of the Herscher quadrangle, at which place it built the Marseilles moraine. A stream discharging probably at a reentrant angle in the front built up the kame a mile north of the Pilot Grove school. A warming of the climate caused the margin of the glacier to retreat from the moraine, with consequent additional deposition of the Marseilles ground-moraine.

A temporary lake may have existed in the Herscher area behind the Marseilles moraine during and after the retreat of the Marseilles ice, as there was a lake up to the 600-foot level in Illinois valley.[8] This lake disappeared before the Minooka stage.

Minooka stage. After the Wisconsin glacier had receded an unknown distance northeast of the Herscher quadrangle during the Marseilles stage, a chilling of the climate caused it to readvance during the Minooka stage. The position of the ice-front in the Herscher quadrangle during Minooka time is not certainly known. If the moraine in the northeast corner is wholly or partly Minooka drift, that moraine marks the farthest advance of the ice into the quadrangle. However, the glacier may have advanced farther and

[8] Leighton, M. M., unpublished data.

whatever drift or moraine it may have deposited may have been entirely removed by subsequent erosion, particularly by Kankakee Torrent. The latter hypothesis has some suport in that the Minooka Ridge ends abruptly at the north bank of Illinois River.

If the gravel along Ryans Creek, which has been described, and at Ritchey Station is outwash from the ice that built the moraine in the northeast corner of the quadrangle, and if that ice was the Minooka ice, then the deltaic bedding of both exposures indicates that a lake up to the 560-foot level existed in the north end of the quadrangle during the Minooka stage at least.

Again, warming of the climate caused the Wisconsin glacier to recede, and the Minooka stage came to a close. Large deposits of gravel in the vicinity of Joliet have been interpreted[9] as deposits from a glacier intermediate in age between the Minooka and Rockdale stages. The gravel along Ryan's Creek and at Ritchey Station may have been deposited from the same glacier, but no other indication of this stage exists in the Herscher quadrangle.

Rockdale Stage. Another chilling caused the Wisconsin glacier to readvance to the position of the Rockdale moraine. It is not certain whether the glacier reached the Herscher quadrangle during the Rockdale stage, but if the moraine in the northeast corner is wholly or in part composed of Rockdale drift, the moraine marks the maximum advance of the Rockdale ice in the quadrangle. And as was postulated in the discussion of Minooka history, if the gravel along Ryans Creek and at Ritchey Station is outwash of Rockdale age, then there was a lake up to the 560-foot level during the Rockdale stage. Once again, warming of the climate caused the glacier to recede and the Rockdale stage was brought to a close.

Kankakee Torrent Stage. A great volume of water, known as Kankakee Torrent,[10] poured down Kankakee Valley at one stage during the Wisconsin glacial epoch. The deposits and erosional features made by the torrent have been described (pp. 66-70). The following lines of evidence uphold the hypothesis of a torrential river:

1. The character and arrangement of the deposits.
2. The existence, location, and trend of fossil bars.
3. The distribution of the deposits.
4. The relations between the areal distribution of the several types of deposits and their relation to the configuration of the basin.
5. The occurrence of these deposits up to, but not above, the 650-foot level.

---

9 Fisher, D. J., The geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, pp. 79-87, 1925.

10 Ekblaw, G. E., and Athy, L. F., op. cit.

6. The occurrence of abundant boulders below and not above the 650-foot level.
7. The presence of wide, abandoned, overflow channels at or below 650 feet in the Herscher area and progressively higher farther east.
8. The character of the bedrock surface in the valley-floor.
9. The character of the inner margin of the Marseilles moraine and the outer margin of the Minooka-Rockdale moraine.
10. The contrast in topographic expression at the 640-foot level in Morris Basin and at progressively higher elevations farther up Kankakee Valley.

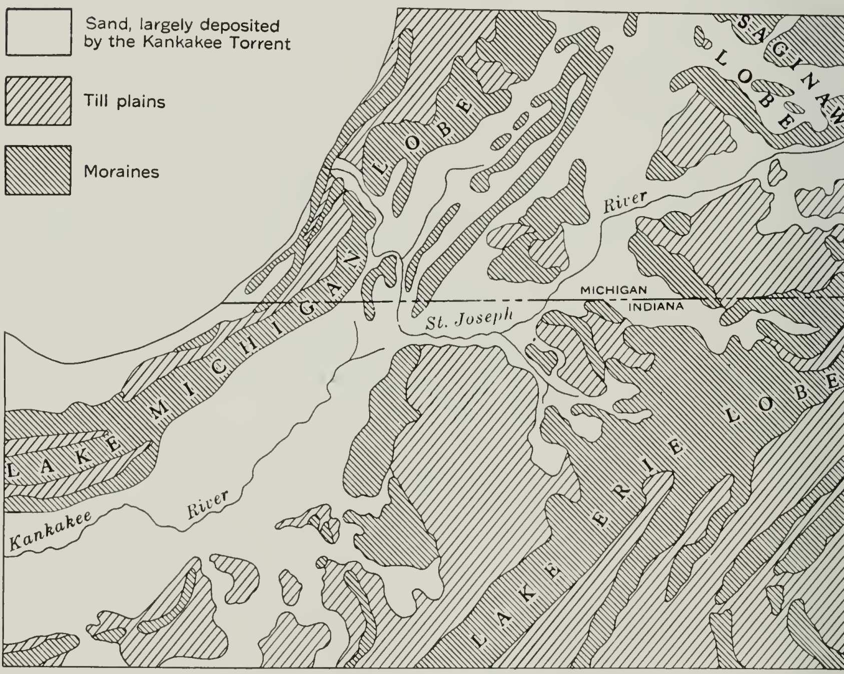


Fig. 31. Relative positions of the ice lobes in Indiana and Michigan (after Leverett). Note the distribution of the sand.

Kankakee Torrent probably existed during the halt and retreat of the Valparaiso ice, when the Michigan, Saginaw, and Erie lobes were conjoined in Michigan and Indiana (fig. 31). These lobes blocked all other valleys so that all the water derived from a large portion of the glacier in the vicinity of the junction of the lobes was discharged through Kankakee Valley. The crushing and crevassing of the ice at the interlobate junctions accelerated melting and drainage; marginal melting was rapid, as indicated by pitted outwash plains,[11] the pits marking sites of ice-blocks isolated by rapid melting; and consequently enormous amounts of glacial waters were concentrated in Kankakee Valley. (See fig. 32.)

As the elevation of the upper Kankakee Valley is about 750 feet, or about 150 feet higher than in the Herscher quadrangle, and as glacial outwash in northern Indiana and Michigan occurs at elevations of 900 feet, Kankakee Torrent had sufficient fall, as well as volume, to give it a velocity sufficient to carry slabs 2 feet in diameter. It scoured all the till except boulders, which were thus concentrated, out of the valley; it cut away the inner margin of the Marseilles moraine and the outer margin of the Minooka-Rockdale moraine in the vicinity of Kankakee and eastward; it built great bars of rubble and sand; it deposited sand, gravel, and rubble along the whole valley.

Erosion was most active in the early stages of the torrent. As the volume of water increased, the gap in the Marseilles moraine, through which the water escaped down Illinois Valley, was too small to accommodate the torrent, and Morris Basin was inundated. The impounded water rose until the volume flowing through the gap, and through other gaps south of Kankakee, particularly one at Chebanse and one through which Iroquois River now flows, equaled that of the torrent. At the time of maximum flow, assuming an average depth of only 20 feet, the cross-sectional area of the torrent at the east edge of the Herscher quadrangle was at least 1,000,000 square feet, whereas the cross-sectional area of the gap at Marseilles was approximately 750,000 square feet.

At the maximum stage of the torrent, which probably coincided with the beginning of the retreat of the Valparaiso ice, the water stood at 640 feet over much of the Morris Basin. It was a great lacustral river which had a powerful current east to west across its center and more quiet waters on either side. Kankakee Torrent poured in at the eastern end of the basin in the Herscher area, but as it entered the flooded basin its velocity was checked, and it dropped much of the detritus with which it was heavily laden. This deposit now forms the tongue-shaped area of sand and gravel that covers much of the Herscher area and extends almost to Morris. The finer sand and silt was carried farther out into the basin or dropped in the more quiet waters along the sides. Most of the silts that are now found over the south half of the basin were thus deposited.

As the Valparaiso ice receded, much of the water from the Erie lobe passed down Wabash River, and the volume of water coming down Kankakee

[11] Leverett, Frank, and Taylor, Frank B., The Pleistocene of Indiana and Michigan and the history of the Great Lakes: U. S. Geol. Survey Mon. 53, pp. 188, 194 and 218, 1915.

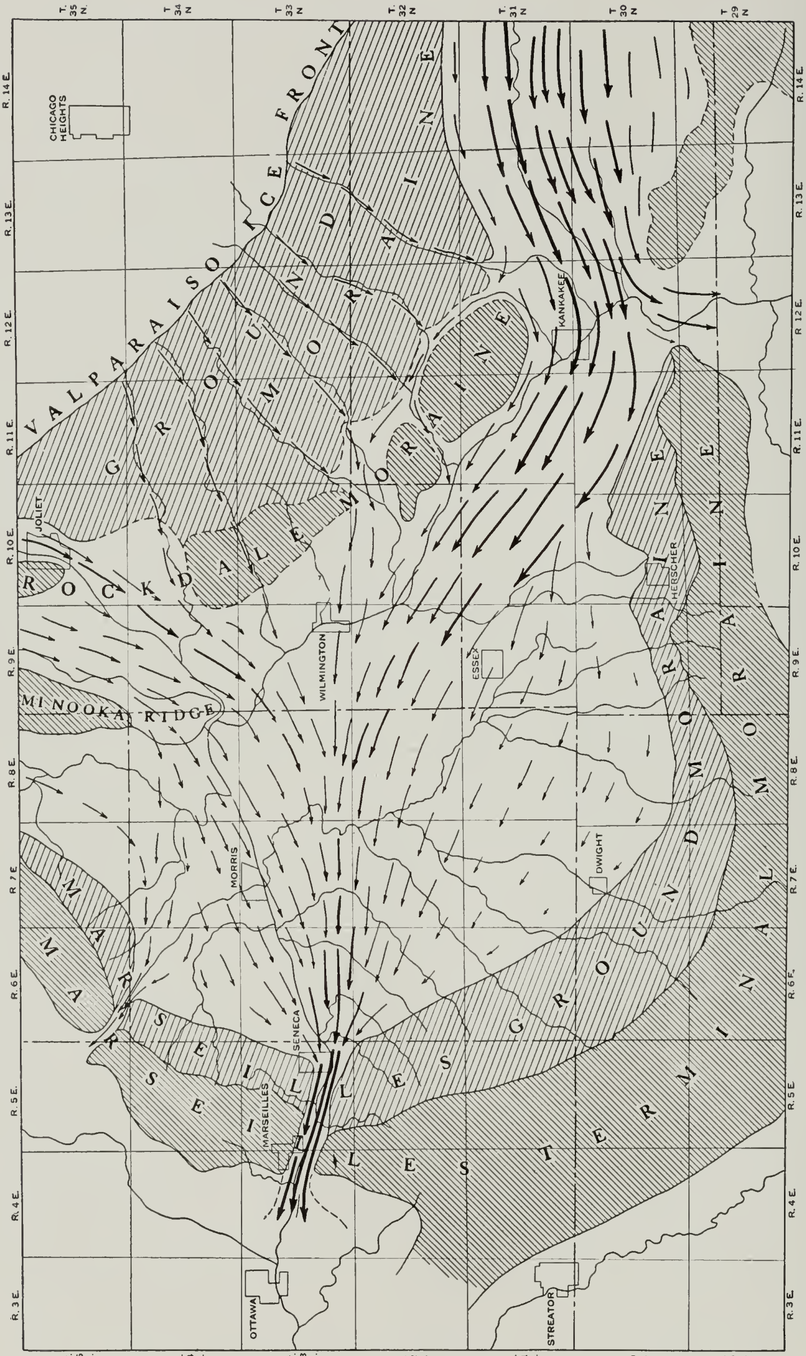


Fig. 32. Morris-Kankakee basin during the maximum stage of the Kankakee torrent. The arrows indicate the distribution and intensity of the current.

Valley was thereby decreased. As the torrent declined, it became divided and assumed a braided pattern among the rock ridges and rubble bars on the flat floor of Kankakee Valley. At one time the water that occupied channels between several bars in the east part of the Herscher quadrangle united to pass down the valley of Horse Creek, part of it spilling over into Granary Creek

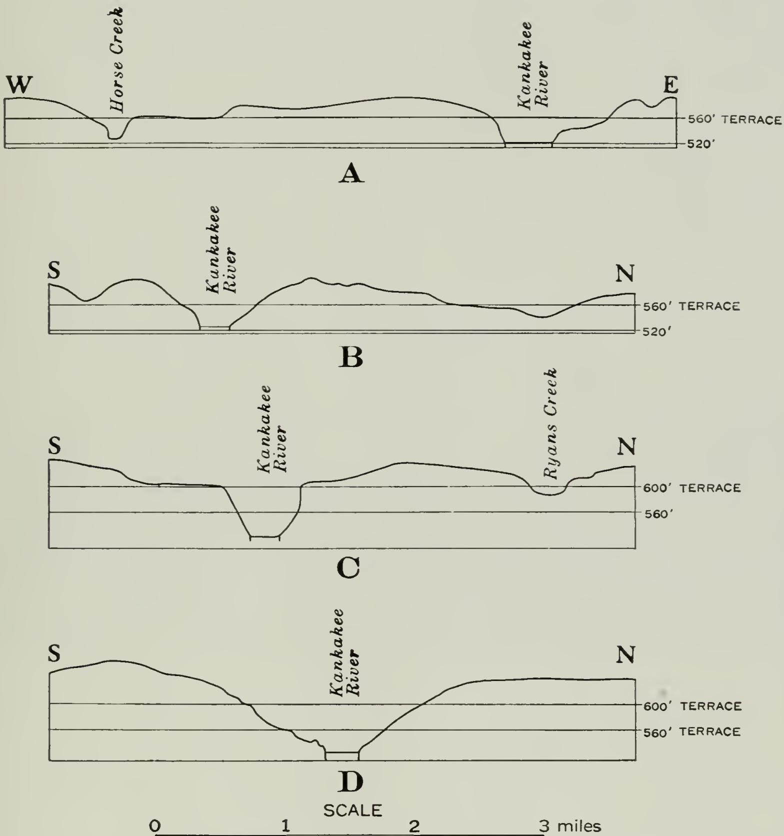


Fig. 33. Profiles showing terraces along Kankakee River and its tributaries.
A—Secs. 24 and 19, T. 32 N., Rs. 9 and 10 E.
B—Secs. 19 and 20, T. 32 N., R. 10 E.
C—Secs. 22 and 27, T. 32 N., R. 10 E.
D—Kankakee-Will county line.

at the low divide a mile and a half southeast of Essex. However, most of the water probably flowed in the part of the valley now occupied by Kankakee River, and the preglacial valleys that are now occupied by Terry and Ryans Creeks were partially reexcavated.

As the size of the torrent decreased, the level of the water in Morris Basin fell accordingly. The highest of the abandoned channels in secs. 21 and 22, T. 32 N., R. 10 E., and the highest terrace along Kankakee River are at about the 600-foot level, which indicates that the water in Morris Basin stood at that level for some time. The lowest of the abandoned channels in the Herscher area and terraces along Kankakee River (figs. 33 and 34) and Horse Creek are at the 560-foot level, which indicates that later the water in Morris Basin also stood at that level. This substage has been also marked by beaches in Morris Basin and has been designated the Lake Morris substage.[12]

As the Michigan lobe retreated, St. Joseph and Pawpaw rivers cut through the moraine and deflected most of the glacial waters away from Kankakee Valley into Lake Chicago. This marked the end of the Kankakee Torrent.

Fig. 34. Kankakee River at Warner Bridge, Kankakee-Will county line. The top of the concrete at the left end of the bridge is level with a 560-foot terrace.

Drainage Changes

The drainage of the quadrangle in pre-Pleistocene times differed in many respects from that of the present. The general slope of the land surface was to the west instead of to the north. A stream heading south of Herscher flowed westward across Norton Township into a larger stream in Livingston County. Horse Creek had the same general course it has today. Ryans Creek was a branch of Terry Creek, and the two flowed northward in a channel in sec. 20 to join ancestral Forked Creek in the Wilmington quadrangle. (see fig. 30.) Kankakee Valley did not exist until after the building of the Marseilles and Minooka-Rockdale moraines, and by that time the preglacial

[12] Culver, H. E., Geology and mineral resources of the Morris quadrangle. Illinois State Geol. Survey Bull. 43, pp. 178-180, 1923.

valleys were probably filled with till and outwash. After these moraines were built, drainage down Kankakee Valley was along the same general lines it is now. Later the whole stream pattern was temporarily obliterated by Kankakee torrent. With the passing of the torrent, Kankakee River chose its present channel with one exception—just above Custer Park the channel was divided by a rock island (sec. 18, T. 32 N., R. 10 E.) so that part of the water joined Horse Creek at Custer Park and part flowed northward around the island after which both distributaries entered Lake Morris. With the passing of Lake Morris, Kankakee River abandoned its course down Forked Creek and lowered its channel to its present level. The presence of Terry Creek with its ancestral channel much deeper than the present Kankakee River and at an angle to it, the vertical rock walls and talus slopes along Kankakee River and the gorge-like character of many of its tributaries indicate the relative youth of the present Kankakee River system.

Recent History

After the final retreat of the Wisconsin glacier the Herscher area was probably not heavily covered with vegetation for some time; consequently the sands were readily susceptible to attack by the winds. Dunes were formed in and across the channels of the torrent, the drainage was interrupted, and swamps and small lakes resulted. As vegetation gained a foothold the dunes became stationary, and the swamps and lakes began to drain or fill. At present only small shallow swamps and no lakes remain.

As the Wisconsin glacier receded it uncovered the St. Lawrence Valley and thus opened an eastward route of drainage for the Great Lakes area. After this was accomplished, the lake in Morris Basin disappeared and Illinois River cut down to its present level. This enabled Kankakee River to lower its floor from 560 feet above sea-level to its present position.

CHAPTER V—MINERAL RESOURCES

General Statement

The rock materials that are of commercial importance in the Herscher quadrangle are coal, limestone, sand and gravel; clay and marl are of minor importance. Oil and gas are known to occur in small, doubtfully commercial amounts. Water resources and soils, as in all agricultural regions, are of fundamental importance.

Coal

Coal is the chief mineral resource of the Herscher quadrangle. At present there is no mining in the area; nevertheless the coal remains as a potential resource to be developed when its mining becomes profitable or desirable.

The western part of the quadrangle was once part of thriving coal mining district. Before the block coals of Indiana and the thick-seam coals of southern Illinois came on the market, the Wilmington district, as this vicinity is known in coal annals, was the chief source of Illinois coal used in Chicago. Many shafts were sunk in the Will County portion of the quadrangle and in the vicinity of Clarke City in Kankakee County. The coal field about Clarke City was considered a part of the Cardiff field to the southwest. When this area was at the peak of its production, over 20 years ago, the population of Clarke City was numbered in thousands; today perhaps a dozen people live in the almost deserted village. Even more recently Torino was a thriving mining town; now only a few empty shacks and a large coal dump mark its site. The Clarke City branch of the Illinois Central Railroad, built along the edge of the Coal Basin to take care of the coal trade, has been lying idle for years. At the time of the study active mines nearest the quadrangle were the Wilmington Star Mining Company's mine No. 7 at Coal City and the Skinner Brothers' mine at Braidwood.

This area is part of the Longwall District or District I of the Illinois Coal Field. The district includes part or all of Bureau, Grundy, Kankakee, LaSalle, Livingston, Marshall, Putnam, and Will counties.

Coals Nos. 2 and 7 are the most important coals. (See fig. 35.) Some thin coals are present, but none of importance has been reported. The general extent of the coal beds is well known north of the center of Norton Township because of the numerous test holes that have been drilled in prospecting. The margins of the coal seams can not be indicated in detail.

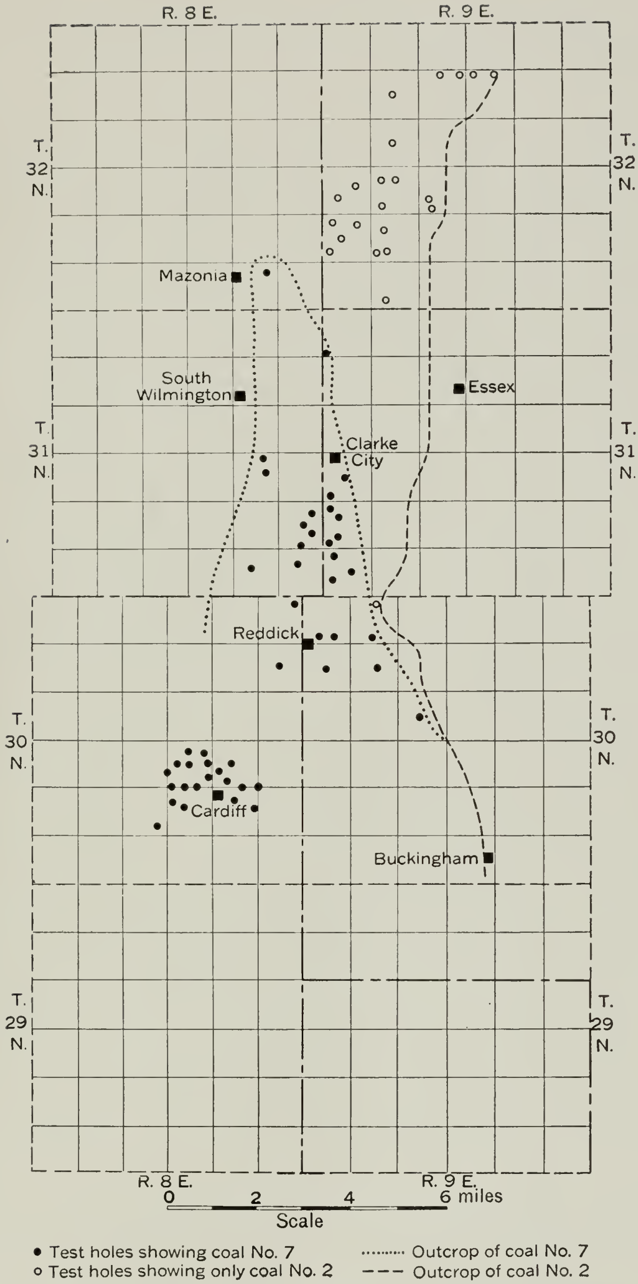


Fig. 35. Distribution of No. 2 and No. 7 coals in the Cardiff-South Wilmington area.

Differences in erosion have caused a decidedly irregular outcrop of coal, and there are a few small outliers of uncertain commercial value.

POTTSVILLE COAL

No coals of value below No. 2 coal are known to occur in the quadrangle. A well drilled below a mine dump in sec. 30, T. 31 N., R. 9 E., showed two thin coals, one 5 inches and the other 9 inches thick. These are probably in the Pottsville formation. In no other place was coal reported below No. 2 coal, except in the northeastern part of the quadrangle where thin seams of "black jack" or "bone coal" are entered in the drill records. Just north of the quadrangle, at Braidwood, three seams of coal aggregating 2 feet in thickness, were reported in about 58 feet of Pottsville sediments.

CARBONDALE COAL

NO. 2 COAL

By far the most important coal in the quadrangle, both in extent and commercial importance is No. 2, which marks the base of the Carbondale. Because of the general absence of appreciable amounts of Pottsville sediments in the area, the eastward limit of the Pennsylvanian strata marks the approximate margin of No. 2 coal.

At the time mining began approximately 25 square miles is thought to have been underlain by recoverable coal, the total amount being 71,000,000 tons. There are no complete records of the amount of coal that has been withdrawn and there is much uncertainty as to the actual position of the outcrop of the coal.

No. 2 coal is not exposed in the Herscher quadrangle at present, but in the Chicago, Wilmington, and Vermilion mine No. 3, in the center of sec. 23, T. 31 N., R. 8 E., Grundy County it has the following characteristics: depth 185 feet; thickness of coal 36 inches; coal bright with occasional dull streaks at irregular intervals; coal quite hard and brittle; occasional thin bands or lenses of marcasite or pyrite; very little calcite noticeable; cleat poorly developed; undercutting of coal is in good fire-clay floor which shows no tendency to rise; good soapstone roof contains numerous concretions and plant fossils.

No chemical analyses of coal from the Herscher quadrangle are available but coal from the South Wilmington and Braidwood areas usually shows a high moisture content and low ash.[1] The amount of sulphur varies from

[1] Parr, S. W., The chemical composition of Illinois coal: Illinois State Geol. Survey Bull. 16, pp. 203-243, 1910.

Hawley, G. W., Analyses of Illinois coal: Illinois State Geol. Survey Coal Mining Investigations Bull. 272-A, 1923.

2 to 5 per cent and the heating value, determined on the coal as received, averages between 10,000 and 12,000 B. t. u. The following is an analysis of coal from the South Wilmington field:

Laboratory number		Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B. t. u.	Unit coal
5375	As received	16.84	38.37	41.19	3.60	1.74	11,508	.....
		dry	46.13	49.53	4.34	2.09	13,838	14,583

There is a strong shale roof over most of No. 2 coal in the quadrangle. Near the outcrop the roof is probably weak, and in many places till overlies the coal. Where No. 7 coal occurs, a sandstone is present in places over No. 2 coal, but a soapstone may intervene between No. 2 coal and the sandstone. The soapstone is usually more than 20 feet thick but is much less in some places.

The floor is a soft grayish shale, improperly called fire-clay. The shale is plastic when wet. According to reports the floor in the old mines was good and showed no tendency to rise along the entries. Thicknesses of underclay varying from a few inches to 11 feet are recorded in well logs.

COALS ABOVE NO. 2 COAL

Several coals of unknown extent and importance occur locally above the No. 2 seam. These are shown in the logs on page 100. The age of these coals is uncertain where none of them can be identified as No. 7 coal. Those lying between No. 2 and No. 7 are, of course, of Carbondale age. The lenticular coal beds occurring a short distance above No. 2 coal are of peculiar interest because in adjacent regions, as at Cardiff and Clarke City, they have been found to be of minable thickness although of only local extent. In the Cardiff field a lens attaining a thickness of 12 feet and known as the "big vein" lies directly on, or as much as 30 feet above, No. 2 coal.[2] In the old Clarke City mine, a similar bed 5 feet thick was present and lay directly on No. 2 coal.

---

[2] Cady, G. H., op. cit., p. 35.

The following logs of coal-test borings show coals between coals Nos. 2 and 7.

Log of coal-test boring in the SW. ¼ SE. ¼ sec 6, T. 30 N., R. 9 E.

	Thickness		Depth	
	Feet	*Inches*	*Feet*	*Inches*
Soil and till	68	..	68	..
Shale	7	2	75	2
Coal, No. 7 (?)	1	3	76	5
Fire-clay	1	7	78	..
Shale	2	..	80	..
Sandstone, calcareous	4	..	84	..
Shale	3	..	87	..
Sandstone, calcareous	7	..	94	..
Shale, dark	10	..	104	..
Sandstone	1	6	105	6
Slate, black	4	6	110	..
Sandstone, calcareous	3	..	113	..
Slate, black	1	..	114	..
Coal	1	7	115	7
Fire-clay	1	..	116	7
Coal	4	6	121	1
Fire-clay	1	8	122	9
Coal	..	7	123	4
Shale	2	6	125	10
Slate, black (pyrite)	4	2	130	..
Coal	5	2	135	2
Shale, dark	24	..	159	2
Coal, No. 2	3	4	162	6
Fire-clay	3	6	166	..
Shale, carbonaceous	1	2	167	2
Shale	3	9	170	11
Limestone	8	..	178	11

Log of coal-test boring near the center of sec. 8, T. 30 N., R. 9 E.

	Thickness		Depth	
	Feet	*Inches*	*Feet*	*Inches*
Soil and till	73	3	73	3
Soapstone	16	6	89	9
Clod, dark	1	6	91	3
Slate, black	9	..	100	3
Clod, dark	6	3	106	6
Coal	5	2	111	8
Fire-clay, slate, clod	6	2	117	10
Coal	..	10	118	8
Clod, fire-clay	4	6	123	2
Sandstone	34	6	157	8
Coal, No. 2	3	2	160	10
Fire-clay	3	2	164	..

The following well log shows the usual sequence:

Log of well in sec. 7, T. 30 N, R. 9 E.

	Thickness		Depth	
	Feet	*Inches*	*Feet*	*Inches*
Soil and till	80	..	80	..
Fire-clay	6	6	86	6
Slate, black	5	..	91	6
Coal, No. 7	3	2	94	8
Fire-clay	7	10	102	6
Limestone	2	..	104	6
Sandstone, calcareous	5	..	109	6
Sandstone, shaly	43	6	153	..
Soapstone	21	..	174	..
Coal, No. 2	3	6	177	6
Fire-clay, "black jack"	2	..	179	6

MC LEANSBORO COAL

NO. 7 COAL

The coal seam known as No. 7 coal in the South Wilmington field underlies parts of Grundy, Livingston, and Kankakee counties. It is not mined at present in the Herscher quadrangle, nor is it exposed. At one time it was mined and shipped from the old Clarke City mine.

In the present bulletin, coal No. 7 refers to the coal from 2 to 5 feet thick lying above and separated from No. 2 coal by 30 to 80 feet of shale, sandstone, limestone, and local coals. The interval between coals Nos. 2 and 7 is less where the intervening coal known as the "big vein"[3] is present. Wherever the interval exceeds 80 feet the "big vein" is missing but where it is 60 feet or less the thick coal occurs. The difference in the interval may be caused in part by the difference between the amount of shrinkage of coal-forming materials and that of other sediments.

About 10 square miles of the Herscher area are underlain by this coal (fig. 32). Perhaps a large part of it could be worked but it is reported to be of rather low grade, and high in sulphur.

The roof, as shown in drill records, is usually a soapstone or black shale, but in places it is a sandstone or a soft noncohesive clay shale, called clod by the miners. The floor is fire-clay 1 to 13 feet thick.

COAL MINING

There are at present no open mines nor mine equipment in the quadrangle. Early mining operations were conducted on a small scale near the margin of the coal where "gin" shafts operated by horse power could be

[3] Cady, G. H., op. cit., p. 101.

Table 8—*Production of coal in Kankakee and Will counties since 1870*

	Kankakee County		Will County	
Year	Quantity *Tons*	Percentage of State production	Quantity *Tons*	Percentage of State production
1870	......	..	228,000	8.6
1880	......	..	984,908	16.1
1886	73,678	.6	287,512	2.5
1887	97,000	.7	284,040	2.2
1888	82,000	.5	347,105	2.4
1889	67,380	.5	342,372	2.8
1890	62,460	.4	288,131	1.8
1891	90,908	.5	233,613	1.5
1892	92,158	.5	113,847	.6
1893	88,700	.4	81,725	.4
1894	57,883	.3	20,717	.1
1895	83,513	.4	38,675	.2
1896	72,395	.3	86,950	.4
1897	180,683	.9	25,682	.2
1898	84,632	.4	40,904	.2
1899	129,262	.5	42,275	.1
1900	109,129	.4	55,323	.2
1901	67,195	.2	56,646	.2
1902	48,439	.1	40,792	.1
1903	74,226	.2	49,240	.1
1904	......	..	76,538	.2
1905	700	.01	137,957	.3
1906	39,499	.09	154,955	.3
1907	26,704	.05	183,985	.3
1908	30,994	.06	162,239	.3
1909	25,000	.04	162,307	.3
1910	......	..	124,652	.2
1911	......	..	178,397	.3
1912	......	..	130,806	.2
1913	......	..	149,926	.2
1914	......	..	136,758	.2
1915	......	..	141,416	.2
1916	......	..	80,885	.15
1917	......	..	89,022	.1
1918	......	..	64,501	.07
1919	......	..	34,700	.05
1919-20	......	..	35,493	.05
1920-21	......	..	19,968	.02
1921-22	......	..	18,144	.03
1922-23	......	..	9,284	.01
1923-24	......	..	5,046	
1924-25	......	..	8,016	
1925 (July 1-Dec. 31)		..	9,342	

sunk and coal removed to meet the local demand. Hoke's shaft and Gamble's shaft in sec. 8, and Conklin's shaft in sec. 19, T. 31 N., R. 9 E., are examples of these. Low mine dumps still mark their locations although they have been abandoned for over 30 years.

With the installation of coal-burning locomotives on the railroads, mining activities were particularly stimulated in the northern part of the area near Godley and Braidwood due to the proximity of Chicago. Large waste heaps in that vicinity indicate that the mines were operated for years. When Clarke City was a thriving mining town, some No. 7 coal and a large amount from the "big vein" was mined, but most came from No. 2 coal. The maximum output was 500 tons daily. Between 500 and 600 acres of No. 2 coal were removed in the 12 years preceding 1908.

The mine last operated in the quadrangle was located at Torino and was known as Diamond Mine No. 6 of the Wilmington Coal Mining and Manufacturing Company. The shaft was located in the NE. ¼ NW. ¼ SW. ¼ sec. 31, T. 32 N., R. 9 E. It was sunk in 1905 and abandoned in 1920. The maximum capacity of 800 tons per day was reached in 1914. Between 210 and 220 acres of No. 2 coal were mined. The vein averaged from 36 to 38 inches in thickness and its depth below the surface was 91 feet at the shaft. The floor and roof were soft, especially in the east entries. About 300 gallons of water per minute were pumped regularly.

Table 8 gives the data on the production of coal in Kankakee and Will counties since 1870.[4]

Much of the area, particularly the region around Torino, shows evidence of surface subsidence[5] where coal has been removed. The water-table stands near the surface most of the year and a couple of feet of subsidence renders it swampy and unfit for agricultural purposes. A large part of sec. 31 was under water during the summer of 1924 as a result of subsidence.

When the thin coals of the Longwall District can be mined in profitable competition with other coals of the country the region will once more regain at least a part of its former prestige. It has advantages in that the coal lies near the surface, roof and floor conditions are good for the longwall system of mining, the coal is of good grade, it stands shipping well, and the district is near large markets.

Clay and Shale[6]

At present none of the clays or shales of the quadrangle are commercially exploited. However, some of the Ordovician, Pennsylvanian and Pleistocene sediments are suitable for the manufacture of ceramic products.

---

4 Cady, G. H., op. cit., pp. 121, 142.

5 Young, L. E., Surface subsidence in Illinois resulting from coal mining: Illinois State Geol. Survey Coal Mining Investigations Bull. 17, 1916.

6 Rolfe, C. W., Purdy, R. C., Talbot, A. N., and Baker I. O., Paving brick and paving brick clays of Illinois: Illinois State Geol. Survey Bull. 9, 1908.

The Richmond shale has a rather fine, even texture, and a low calcium carbonate content, especially in its weathered portions. It is very plastic and smooth when wet. Where essentially noncalcareous it might possibly be used in the manufacture of brick or hollow ware, or in the manufacture of cement. However specific tests must be made before the value of the clay can be stated with accuracy.

There are several Pennsylvanian shales which might prove suitable for brick or tile making. The shale above No. 2 coal at the Chicago, Wilmington, and Vermilion coal mine No. 1 at South Wilmington just west of the Herscher quadrangle has been shown by analysis to be good for common and face brick and hollow ware.[7] This shale is available only when the coal mines are in operation. The clay in the mine dumps is a possible source of

Fig. 36. A view of Lehigh Stone Company quarry from the east. Note the crusher and stock pile in the distance. The rock in the foreground has been stripped.

material for common brick and tile. Pottsville clay below No. 2 coal may prove to be of value when more is known about it.

The glacial till usually contains too many boulders and pebbles for use in making clay wares. Locally the till is relatively free from pebbles and may be a source of clay for brick or tile as at Coal City.[8]

Limestone and Dolomite

The quarrying of limestone is at present the chief mineral industry in the quadrangle and has been carried on for many years. The quarry of the Lehigh Stone Company in sec. 7, T. 30 N., R. 14 W., is the largest (fig. 36).

[7] Stull, R. T., and Hursh, R. K., Tests on clay materials available in Illinois coal mines: Illinois State Geol. Survey Coal Mining Investigations Bull. 18, pp. 51-53, 1917.

[8] Culver, Harold E., Geology and mineral resources of the Morris quadrangle: Illinois State Geol. Survey Bull. 43, p. 196, 1923.

A small quarry is being operated by the township at Bonfield. Other small, local quarries are in sec. 35, T. 32 N., R. 10 E., sec. 26, T. 32 N., R. 10 E., and sec. 20, T. 32 N., R. 10 E. (Pl. I).

The stone from the small quarries is used for road construction or repair and as a foundation stone for farm buildings. The product of the Lehigh Stone Company is largely crushed stone, which is used for flux, aggregate, agricultural limestone, ballast, and building stone. The magnesia and sulphur content of the rock is too high for use in cement.

The amount of stone available for quarrying in the Herscher quadrangle is very great. There are several large areas where the limestone is within a few feet of the surface. Where the bedrock is covered by two feet or less of surface materials it is shown on Plate I as outcropping. Some of these areas are near enough to railroads to permit quarrying on a large scale. There are also many sites where small quarries for local supply could be opened at a low cost.

In general the Edgewood limestone is too soft or shaly for aggregate or construction purposes, but it has been used to some extent for surfacing roads.

The Kankakee limestone is not desirable for construction purposes because it weathers to a yellowish or reddish brown color very soon after quarrying. It makes an excellent stone for road building and repairing. It has not been used as agricultural limestone, but its high calcium carbonate content indicates that it is well suited for this purpose.

The Niagaran dolomite is an excellent stone for the various purposes mentioned above. Judging from the analyses of Lehigh stone (Table 9) most of the Niagaran outcropping within the area would serve excellently as agricultural limestone.

Table 9—*Analyses of Lehigh stone* [a]

	Sample 1	Sample 2	Sample 3	Average
Iron and alumina	1.2	1.4	1.1	1.2
Insoluble matter	6.3	3.7	8.3	6.1
Calcium carbonate	50.8	63.8	50.4	51.7
Magnesium carbonate	41.6	41.2	39.5	40.8
Calcium carbonate equivalent	100.3	102.7	97.4	100.0

The analyses show that the Lehigh stone has a high calcium carbonate equivalent and is very suitable for neutralizing acid soils. This same stone is a high-grade product for road building as shown by tests in Table 10.

[a] Analyses by the Illinois State Agricultural Experiment Station.

Table 10—*Average of eight physical analyses of Lehigh stone*[a]

Specific gravity	2.64
Weight in pounds per cubic foot	165
Water absorbed in pounds per cubic foot	2.65
Per cent of wear	5.2
French coefficient of wear	9.5

The rubble deposit of Kankakee Torrent, especially that in the area south of Bonfield, is largely limestone. In many places it is from 5 to 10 feet thick, and has a very shallow soil covering, and could be removed readily with a steam shovel and crushed for road use. Its only impurities in many places are clean sand and gravel.

Gravel

All of the gravel deposits within the quadrangle are a part of the Pleistocene sediments, that is, glacial outwash, torrential gravels, or kames. The northern part of the quadrangle is particularly well supplied with gravel, but much of the gravel is rather coarse and commonly contains pebbly glacial clay. The clay occurs in an amount too small to decrease the value of the deposit appreciably. The locations of most of the pits in the quadrangle are shown on Plate I.

Deposits of well-rounded gravel are found along Ryans Creek in sec. 21, T. 32 N., R. 10 E. This gravel is even textured and not very coarse, and its sand content is rather small. It makes an excellent road material either crushed or uncrushed and can be used in concrete. There is a similar deposit south of Kankakee River in sec. 19, T. 32 N., R. 10 E. These gravel deposits are thought to be remnants of glacial outwash from the Minooka or Rockdale ice.

The deposits of Kankakee Torrent in many places consist of coarse gravel and sand which could be used as road ballast. A few small pits in these gravels supply stone for road repairing and local concrete work.

The Marseilles kame in sec. 1, T. 29 N., R. 10 E., contains a large amount of poorly sorted gravel, sand, and silt in beds and pockets. The material is being used mainly for road repair. The clay and silt content renders the material unfit for concrete, but it is used to some extent because sand and gravel are scarce in that vicinity. (See fig. 37.)

Sand

The whole northern half of the Herscher quadrangle is covered with sand. Most of the sand is clean, even textured, and angular and can be

[a] Compiled from Krey, F., and Lamar, J. E., Limestone resources of Illinois: Illinois State Geol. Survey Bull. 46, pp. 53-56, 1925.

used as fine aggregate, in small concrete structures, or in concrete surfacing, or in railroad filling. Mechanical analyses of two samples of this sand are given on page 72.

Sharp sand, either clean or containing a small amount of iron oxide, could be used as core sand for small castings and brass work in foundries. Any high silica sand of fine, even texture may be used as core sand, but the presence of some ferruginous material is sometimes desired. A good core sand should be even textured, highly refractory, and have, if possible, some bond or cohesive material such as iron oxide that will not "burn out" when heated. Too much bond reduces the permeability and renders the sand of little value for core-making because it will not allow the gases to escape from the casting.

Fig. 37. Gravel in the kame in sec. 1, T. 29 N., R. 10 E. The pockets of silt and rock flour are detrimental to its use.

A fine-textured core sand for the manufacture of small articles, such as hardware or brass and aluminum ware, occurs in the vicinity of Ritchey and Custer Park. In this locality gravel hills are capped by wind-blown sand which varies in thickness from 3 to perhaps 20 feet. The upper 2 to 4 feet is a rather "sharp," fine, even-textured sand and contains a small amount of iron oxide bond which gives it a yellowish brown color. This sand is sold as core sand.

Below the upper sand there is from 4 to 7 feet of reddish-brown, very compact molding sand. This sand is similar to the core sand except that it contains a much greater amount of iron oxide, and therefore it has greater cohesion and less permeability. It could probably be used as a molding sand for small and medium sized castings.

The molding sand at Custer Park has not been shipped to any great extent, but it has been actually tried and found to be serviceable. The total amount of this sand can not be accurately determined, but there is at least 40 acre-feet of molding sand of varying quality on either side of Kankakee River in the vicinity of Custer Park.

The amount of core sand in this vicinity is approximately the same as that of molding sand. Most of the available supply on the south side of the river at Custer Park, and about five acres on the north side, has been already removed (fig. 38).

Fig. 38. Core sand pit across the river from Custer Park. The face is about 4 feet high—three feet of core sand and 1 foot of stripping.

There are three producers[9] near Custer Park who ship approximately 275 cars of core sand per year. Most of the sand is used in Chicago.[10]

Marl

In sec. 27, T. 32 N., R. 10 E., on a terrace on the north bank of Kankakee River, is a small deposit of marl. The terrace is cut in Richmond shale and is covered with impure calcium carbonate formed by the evaporation of spring water. The carbonate is also partially made up of the remains of Pleistocene and Recent shells, and for that reason is here called a marl, although it is just as truly a travertine.

9 Mineral Industry Map and Directory, p. 54, January 1, 1927.

10 For a description of the properties of molding sand and the location of deposits in Illinois, see Littlefield, M. S., Natural bonded molding sand resources of Illinois: Illinois State Geol. Survey Bull. 50, 1925.

The deposit is rather limited in extent, probably covering not more than three acres, and varies in thickness from 1 to 5 feet. It contains some limestone fragments and other impurities which have been washed down the slope during the process of its accumulation, but because of its unconsolidated state it could be used as a local source of lime for soils.

Oil and Gas

Several factors determine whether or not oil may occur in a given area. It is not necessary that prospectors be able to recognize all of them, but they are nevertheless instrumental in the formation and accumulation of the oil.

First of all there must be a source-bed in which the oil was formed. Any bed which once contained a large amount of organic matter buried in such a way that it was preserved and metamorphosed through physical, chemical, and bio-chemical processes into petroleum, is a source-bed. Such a bed is usually shale or limestone, but frequently it is impossible to recognize the source-bed from which an oil came because the reservoir-bed in which the oil occurs may not be the source-bed. The presence of a probable source-bed in an area is no indication that oil is sure to occur but assurance that no source-beds are present in the vicinity would eliminate the area from favorable consideration. It is not necessary to find the source-bed in oil prospecting if the reservoir-bed is known to have yielded showings of oil. Recognition of the source-bed is important, however, for other areas in which it is known to occur should be studied for the favorable occurrence of reservoir-beds, cap-rock, and structure. If conditions are right, such areas should be tested for oil.

A second requisite for oil accumulation in commercial amounts is the presence of a suitable reservoir-bed, such as a porous sandstone or a porous, cavernous or fissured limestone. Oil that is widely disseminated through an impervious rock cannot be pumped out in commercial quantities. The rock must be of such a character that the oil is free to flow readily under pressure.

Another requisite is that there be a cap-rock, that is a shale or an impervious stratum, over the reservoir-bed to prevent the upward migration and dissemination of the oil.

A fourth necessary condition is the presence of rock structure suitable for the accumulation of oil. As oil is usually associated with water and as there is an active circulation of the underground waters, the structures must allow the oil to accumulate above the water or in places where it may be trapped out of the course of the circulating waters. The most common structures which satisfy the conditions are domes or anticlines and terrace structures on monoclines. The oil would be expected to accumulate on the high part of the structure in the Illinois region.

In most regions, such as the Herscher area, drilling need not be carried on blindly because the formations in the area are known and those which carry oil in other localities are also known. Furthermore, drill records show the quantity of oil encountered.

Small oil seeps have been reported in various parts of the quadrangle but care should be exercised before pronouncing the film on the surface of pools of water to be oil. Usually such a film is due to hydroxide of iron and not to oil. If it is an iron film it will break up when stirred with a stick but if it is oil it will not break. The iridescent iron film is usually more lustrous than an oil film.

The Platteville-Galena and the Pennsylvanian formations are the only ones in the area which have been known to carry oil. The Pennsylvanian does not merit consideration because it is too near the outcrop and lacks the proper structure. The Platteville-Galena limestone, which is capped by the impervious Richmond shale, is the most likely reservoir-bed in the area. There are small fields which show some oil[11] in the "Trenton" (Platteville-Galena) in Lake, Newton, Jasper, Porter and La Porte counties in northwestern Indiana, but they have not been operated at a profit. One of these fields is about 40 miles east of the Herscher quadrangle.

In the area about Herscher approximately 20 wells have been drilled into the Galena. About 12 of these are located in the northern part of sec. 32, T. 30 N., R. 10 E. Of these nine were pumped for eight months and then abandoned. The largest well produced 25 gallons of oil in 24 hours of pumping, but most of them produced from 5 to 10 gallons daily. All were small gassers; the largest one flowed about 32,000 feet at from 6 to 10 pounds pressure. Although the available data do not permit a definite conclusion as to the cause of the small production of the wells near Herscher, it is believed that both low pressure in the reservoir rock and the small size of the openings in the reservoir are responsible. Probably the low permeability of the reservoir is the more important factor.

The well drilled for oil near Essex in the SW. ¼ SW. ¼ sec. 11, T. 31 N., R. 9 E., gave a good showing of oil and considerable gas in the upper part of the Galena. Water in many of the wells which penetrate the Galena is highly mineralized and gives off gas. These wells have proved the presence of oil and gas in small but not commercial amounts.

The exact delineation of structure in the Galena from known data is impossible. There is without doubt an anticlinal fold which seems to have an east-west trend in the vicinity of Herscher. Drilling in that area however

11 Logan, W. N., Petroleum and natural gas in Indiana: Indiana Dept. of Conservation, Div. Geology, 1920.

has indicated that oil in commercial quantities almost certainly does not exist there.

No favorable structure is known to occur where the Essex well was located. The anticline crossing Kankakee River two miles west of the Kankakee-Will county line may also exist in the Galena formation and may be worth testing, but the chance of obtaining oil in commercial quantities is exceedingly small.

Soils

The relation of various geologic processes at work in the quadrangle to the types of soils formed is interesting.

A detailed map of the soils of Kankakee County has been prepared by the University of Illinois Agricultural Experiment Station.[12] The types of soils listed in this soil report are as follows:

Upland prairie soils
- Brown silt loam
- Brown silt loam on rock
- Black clay loam
- Drab clay loam
- Brown sandy loam
- Brown sandy loam on rock
- *a* Gravelly loam

Upland timber soils
- *a* Yellow-gray silt loam
- *a* Yellow silt loam
- *a* Yellow-gray sandy loam

Terrace soils
- Black clay loam
- Brown silt loam over gravel
- *a* Brown-gray silt loam on tight clay
- Brown sandy loam
- Brown sandy loam on rock
- *a* Yellow-gray sandy loam
- Dune sand

Late swamp and bottom-land soils
- Deep peat
- Medium peat and clay
- Medium peat and sand
- *a* Peaty loam on rock
- Mixed loam
- *a* Muck

The best and most abundant soils are the brown silt loam and the brown sandy loam. The brown silt loam soil covers most of the morainic area,

---

a Not reported in the Hersher quadrangle.

12 Hopkins, Cyril G., Mosier, J. G., Van Alstine, E., and Garrett, F. W., Kankakee County soils: University of Illinois Agr. Exper. Sta. Soil Rept. 13, 1916.

but some black clay loam occurs in the originally undrained areas of the uplands. The brown sandy loam constitutes the main soil in the area covered by Kankakee Torrent.

The brown silt loam soil is composed of the loess-like material which covers most of the morainic area. Where this fine wind-blown material has been washed away, till constitutes the base from which the loam originated. The soils are known as "prairie" soils and are among the best in the State.

The brown sandy loam was formed mainly from the sand and pebbly silt carried by Kankakee Torrent but there has been some admixture by water and wind action. This soil is less sandy in northern Norton, northern Pilot, and southern Essex townships than it is farther north. In the places mentioned it is perhaps even a better soil than the silt loam, because it is more open and easier to farm. Farther north it is too sandy and is rather low in plant foods, much of the sub-soil is "quicksand," and drainage is very difficult because the tile drains cannot be kept open and in place.

The large area of dune sand in the northern part of the region is practically worthless for cultivation without the application of large amounts of organic matter and lime. Although fair crops could be raised on these dunes, deforestation usually results in disaster because the dunes begin to migrate.

Swamps cause a great amount of waste land in the sand area. Water does not usually cover the area to a great depth, but due to the peat or "quicksand" below, the swamp land cannot be drained except possibly by the construction of open ditches. Because small bogs are so numerous and the soil is so poor it is probably more economical to use such land only for pasture.

Water Supply

Herscher quadrangle is well supplied with water, from both surficial and bedrock sources. Most of the water is hard, and much of it is sulfurous. The water is obtained either from shallow wells in the glacial till or sand and rubble or from wells in the Niagaran, Alexandrian, and Pennsylvanian series, and very rarely from springs. Few water wells in the quadrangle go below the Silurian limestone.

Most springs occur at the Edgewood-Richmond contact along the bluffs of Kankakee River. There are innumerable seeps and small springs wherever this shale is exposed. The impervious shale allows the descending water to pass through it very slowly, if at all, and causes most of it to accumulate in the lower beds of limestone above and there develop a lateral circulation. Some of these permanent springs provide excellent drinking water and are a boon to the campers and fishermen along the river. Two exceptionally large springs occur in the SE. 1/4 NE. 1/4 sec. 27, and in the SE.

¼ NE. ¼ sec. 35, T. 32 N., R. 10 E. Other small springs occur at various places in the sand and till and provide excellent water for stock.

Although water in small quantities is easily obtained from shallow wells, only exceptional shallow wells have large flow or do not "sand up" when pumped for any considerable length of time. For these reasons, as well as because of danger of contamination by surface waters, deep wells are usually preferred.

In the vicinity of Essex and northward, the sand and rubble rests on till and due to its flat attitude and relatively low elevation is saturated below depths of 5 to 10 feet during most of the year. A well may be made simply by driving a well point down to the water-table. Rapid pumping soon brings up sand, but by slow pumping a large quantity of water is obtained. Wells of this kind are practically the only ones found in the area north of Essex.

Along the western margin of the quadrangle and south of the sand belt the water is obtained from the Pennsylvania strata. The wells vary in depth, and apparently many of the strata are acquifers. The water, however, is usually sulphurous, and much of it is salty. Some of the wells emit considerable quantities of gas. The well at the town hall in Reddick is 268 feet deep and is in limestone underlying the Pennsylvanian formation. The water has a high salt content as its analysis shows.[13] It is probable that better water could be obtained from the St. Peter sandstone which lies at a depth of from 700 to 750 feet in that vicinity.

Most of the wells in the southern part of the quadrangle get water from the glacial till. Many, however, penetrate the underlying Silurian limestone at depths varying from 50 to 150 feet. The limestone is thin, but as it overlies the impervious Richmond shale, it carries a large quantity of excellent water. Over most of the quadrangle east of the "Coal Measures" and north of the Marseilles moraine, water is obtained from the Silurian limestone. It is rather hard but rarely if ever sulfurous. Some of the wells in this portion of the quadrangle penetrate the Galena dolomite, but much of the water is salty or contains considerable sulfur.

The water obtained in the few wells which enter the Galena dolomite is highly mineralized. If a supply of good water can not be secured from the surficial deposits or the Silurian limestone, it seems advisable to try the St. Peter sandstone which occurs at a depth of about 500 feet at Custer Park and 750 feet just south of Herscher.

The location of many of the wells which penetrate bedrock is shown on Plate I. Few of these are flowing wells, but nearly all are under considerable pressure, which lifts the water toward the surface. A few of the wells east of Herscher are flowing wells but these are not differentiated on the map.

---

13 Anderson, Carl B., The artesian waters of northeastern Illinois: Illinois State Geol. Survey Bull. 34, p. 241, 1919.

INDEX

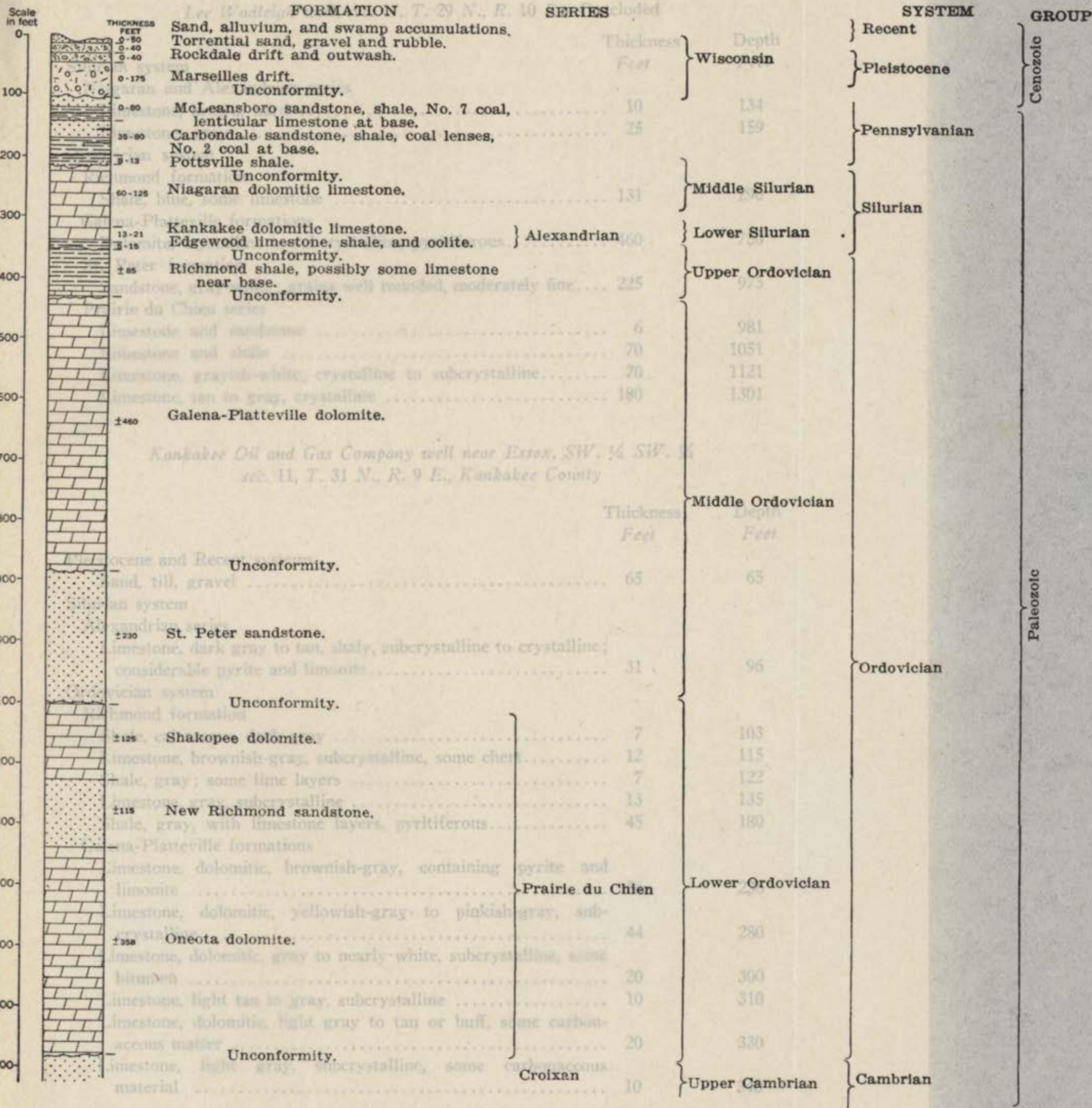
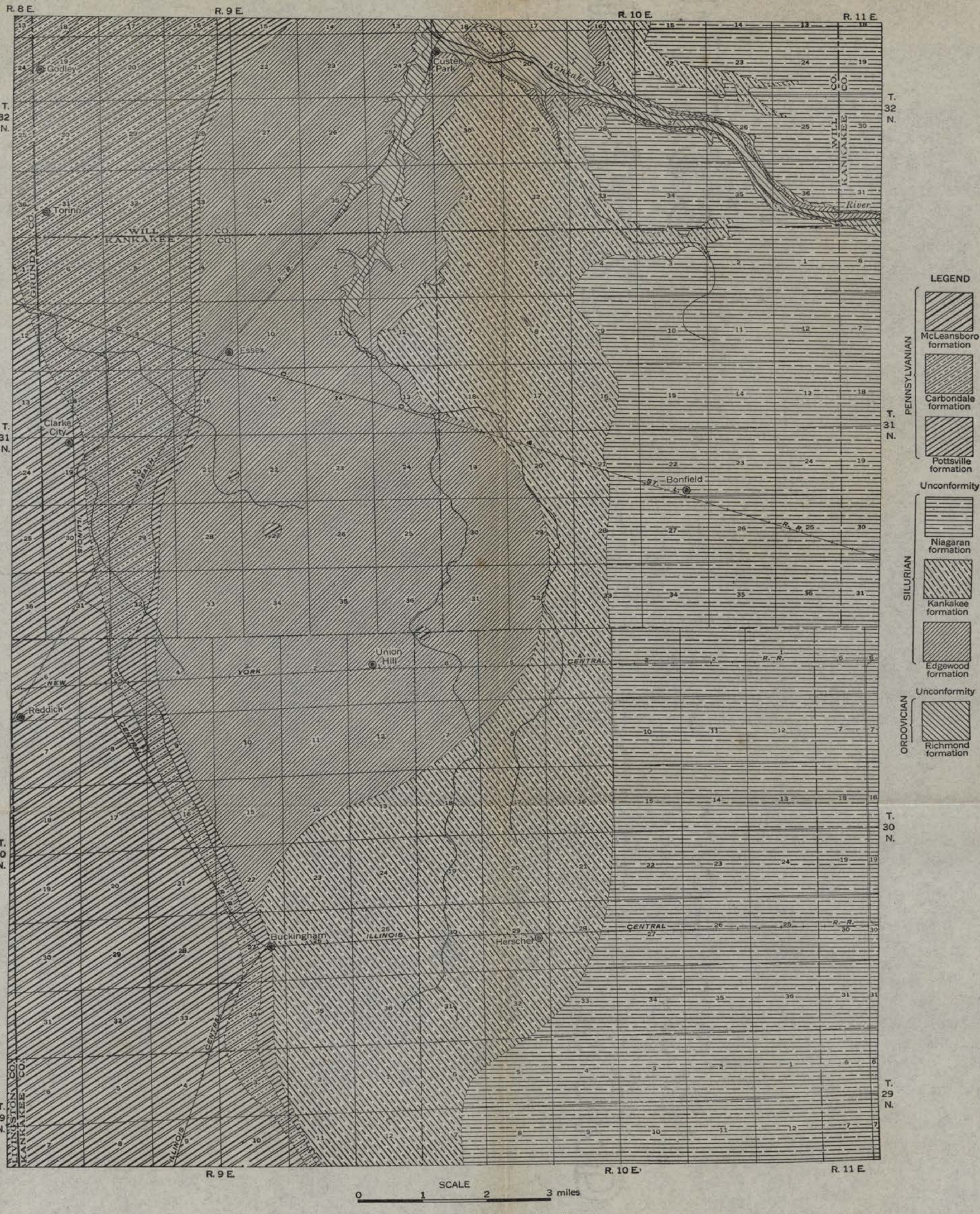


Fig. 7. Columnar section of the rocks of the Herscher quadrangle.

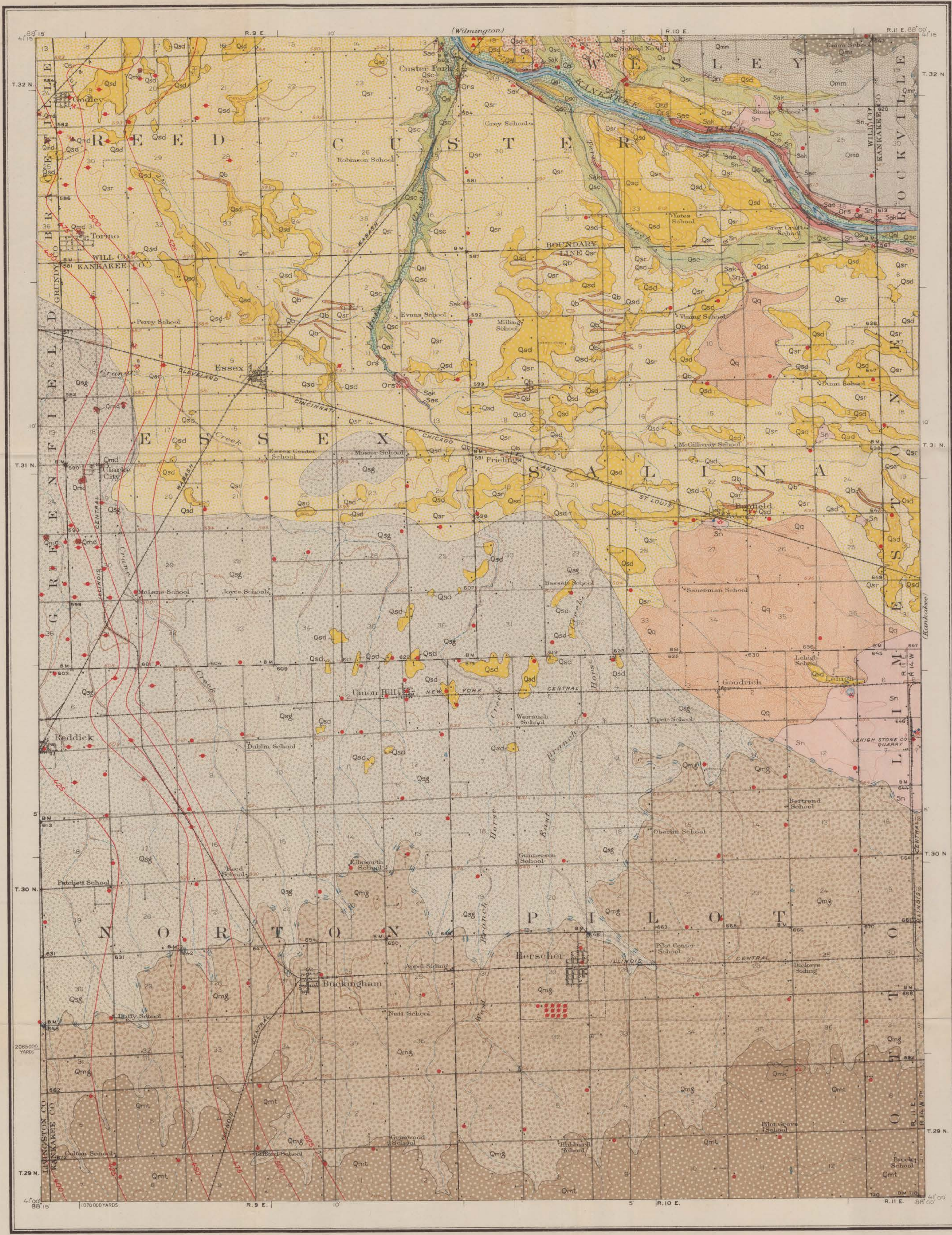


Areal geology of the Herscher quadrangle.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, DIRECTOR

GEOLOGICAL SURVEY DIVISION
M. M. LEIGHTON, CHIEF
URBANA, ILLINOIS

HERSCHER QUADRANGLE
BULLETIN No. 55, PLATE I



LEGEND

Mine dumps (Qmd)

Alluvium (Qa)

Torrential bars modified by wind action, and sand dunes (Qsd)

Unassorted sand and gravel in abandoned channels and high-level terraces (Qsc)

Deep sand over rubble (Qsr)

Coarse angular rubble over bed rock (Qq)

Torrential sand and rubble covering older outwash gravels of economic importance (Qs)

Sand and rubble bars (Qb)

Thin sand, pebbly silt and fine gravel over Marseilles ground moraine (Qsg)

Minooka-Rockdale terminal moraine modified in part by Kankakee Torrent (Qmr, Qmm)

Coarse gravel over bed rock. Minooka-Rockdale outwash (Qmo)

Marseilles ground moraine (Qmg)

Kame associated with the Marseilles moraine (Qmk)

Marseilles terminal moraine (Qmt)

Recent — Pleistocene (Wisconsin) — Kankakee torrential deposits — QUATERNARY

UNCONFORMITY

Pottsville (?) formation
(sandstone, sandy shale and carbonaceous material in sinks and fissures in older limestone)

Pennsylvanian

UNCONFORMITY

Niagaran dolomite (Sn)
(dolomitic limestone, gray to brown, pyritiferous, thin to massive bedded)

Niagaran

UNCONFORMITY?

Kankakee limestone (Sak)
(dolomitic limestone, thin to massive bedded gray to brown, vesicular, contains fossiliferous beds)

Edgewood limestone (Sae)
(brown, dolomitic, fossiliferous limestone; fossiliferous shaly limestone; blue limestone; also ferruginous, oolitic, dolomitic shale)

Alexandrian — Silurian

UNCONFORMITY

Richmond formation (Ors)
(olive green, plastic shale, occasional thin limestone beds, non-fossiliferous)

Ordovician

Greatest extent of the Kankakee torrential waters

ECONOMIC AND STRUCTURE DATA

Structure contours on the top of No. 2 coal (450, 425)

Abandoned coal mine

Stone quarry

Sand and gravel pit

Foundry sand pit

Coal test

Abandoned oil and gas well

Artesian well

Topographic base map surveyed in cooperation with U. S. Geological Survey

Scale $\frac{1}{62500}$

1 — 0 — 1 — 2 — 3 — 4 Miles

1 — 0 — 1 — 2 — 3 — 4 — 5 Kilometers

Contour interval 20 feet.
Datum is mean sea level.

APPROXIMATE MEAN DECLINATION, 1923

Geology by L. F. Athy
Geologically surveyed in 1924

ECONOMIC, STRUCTURAL AND SURFICIAL GEOLOGY OF THE HERSCHER QUADRANGLE

(Topographic maps without geologic data may be obtained by addressing the Chief, State Geological Survey, Urbana, Illinois.)

PLATE I